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Contents

	PAGE
Forthcoming Events	221
A Problem to be Resolved	221
The Proposed Birmingham School	221
Correspondence	222
The Use of Sodium Carbonate in Iron and Steel Works	223
The Potentialities of Cast Iron	227
A Machine-Tool Demonstration Hall	228
Projected British Foundry School	229
East Midlands Foundrymen Elect New Officers	230
This Week's News in Brief	231
Trade Talk	231
Obituary	231
New Companies	231
Personal	231
Company Reports	231
Contracts Open	231
Raw Material Markets	232
Catalogue Received	232

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION

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Forthcoming Events

APRIL 12

Institute of Metals (London Local Section):—Annual general meeting in the Rooms of the Society of Motor Manufacturers and Traders, Limited, 83, Pall Mall, London, at 7.30 p.m. Open discussion.

Institute of British Foundrymen

APRIL 7

Lancashire Branch:—Annual general meeting at Engineers' Club, Manchester, at 4 p.m. "Production Costs and Selling Prices," Paper by A. Hodson.

APRIL 11

Lancashire Branch (Preston Section):—Annual general meeting at Technical College, Preston, at 7.30 p.m. "Moulding Machines and Fettling Plant," Paper by F. W. Neville.

APRIL 13

Middlesbrough Branch:—Annual general meeting at the Cleveland Scientific and Technical Institute, Middlesbrough, at 7.45 p.m. Further Report of Technical Section. Short Paper and general discussion.

APRIL 14

West Riding of Yorkshire Branch:—Meeting at the Technical College, Bradford, at 6.30 p.m. "Foundry Costs," Paper by F. Whitehouse.

APRIL 20

Sheffield and District Branch:—Annual general meeting at the Grand Hotel, Sheffield, at 7.45 p.m. "Alloys in the Ironfoundry," Paper by J. Roxburgh.

Birmingham, Coventry and West Midlands Branch:—Annual general meeting at the James Watt Memorial Institute, Birmingham, at 7.30 p.m. "The Mechanical Production of Cores," Paper by W. J. Molineux.

A Problem to be Resolved

Recent contributions to metallurgy have demonstrated in the clearest possible manner that modern cast irons have a number of engineering properties unexcelled by any other alloy obtainable at a competitive price. With these developments trade names, such as Ni-Resist, Nimol, Nomag, Meehanite, Nicrosilal and so forth, have been registered. This raises the general question as to whether founders wish to suppress the basic fact that these alloys are fundamentally cast iron. Obviously, they wish to attach to the registered name as much goodwill as possible, and so may, erroneously we think, be tempted to suppress wherever possible the words "cast iron," which the brand name qualifies. As practically all founders still make ordinary cast iron, it would appear that the newer developments have created an excellent opportunity to place the basic metal on a higher plane. It is readily understandable that, when firms are paying for extensive alloy additions, or licences to manufacture, they fear that buyers habitually purchasing cast iron may have the price-range too well fixed in their minds to accord proper recognition of the intrinsic worth of the newer materials. Yet a better appreciation of the true worth of cast iron as a basis material for engineering construction by the buyers, would lead to better prices being given for grey-iron castings in general. After all, cast iron has really a better status amongst engineers than grey-iron castings. Expressed differently, they appreciate the test-bar properties better than the moulder's art, and in their calculations they make very large allowances for the human element introduced during the fabrication process. This should be borne in mind when confining propaganda to one or a range of the newer alloys, and by clarifying the mind of the buyer so that he appreciates the difference between the engineering properties of the metallic mass of the casting and the moulding defects exhibited by an individual sample. If this be consistently done by the salesman, then there will be less need to hide the fact that the new materials are in truth high-grade alloys which, whilst maintaining the fundamentally excellent properties of cast iron, possess them either in an enhanced form or present specially useful characteristics.

The Proposed Birmingham School

We recently published the first statement of the proposals for the establishment of a specialised foundry school in Birmingham. The first point to make clear is that the scheme in no way clashes with or overlaps the Sheffield scheme, to which we have recently given extended reference in our columns. The essentially complementary character of the two schemes was plainly put by Prof. Andrew in the Birmingham discussion, which is printed in this issue. For the rest, it is proposed, quite simply, that a school shall be established capable of taking men for a period of one year on a full-time day course, the time occupied, Mr. Pearce suggests, being equivalent to a ten-year ordinary evening course. Furthermore, it is proposed that the school shall be wholly governed by the industry, and that for this purpose it should be supported by and governed by a committee nominated by the various bodies in the industry having a representative character; that is the scientific and technical bodies, the manufacturers' associations and the research associations.

The scheme is designed to complete the educational structure which has been built up during the past few years, in the government of which the industry takes an active part. It requires from the industry two things—firstly, the comparatively insignificant sum of £500 a year, and a willingness to release such students as may be able to profit from the course. If these conditions are met, then the official support of the Board of Education will be forthcoming to such an extent as to enable the school to function on a proper basis. One important problem will not arise—that of absorption of the men who pass through it, for they will all be men who are actually in the industry, committed to it for their livelihood, and thus able to return to it by virtue of their experience and practical training as well as of their special knowledge. Doubtless, the next few weeks will show how far the proposals commend themselves to the industry, and if the discussion at Birmingham is any guide, their reception should be very favourable. The proposals themselves show clearly how many of the initial difficulties of accommodation and so on have been overcome, and the suggestion that a start might be made in October next shows that no real difficulties are anticipated if the scheme really meets a need.

XUM

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents]

Cupola Practice

To the Editor of The Foundry Trade Journal.

Sir,—In commenting upon some of the points raised in Mr. Neville's able and interesting letter, published in your issue of March 22, the writer would like to correct a statement made by Mr. R. C. H. Weeks in his very informative Paper when referring to the balanced-blast cupola. Whilst Mr. Weeks has very closely followed the writer's earlier description of the work of Wüst, which led to the conception of the air-controlled tuyere arrangement, the statement that "only sufficient oxygen is admitted actually to burn the coke to carbon monoxide" at the lower row of valved tuyeres is not quite correct. The aim of the writer has been to produce in the lower tuyere zone of the coke bed a gaseous atmosphere of neutral character in which no free oxygen is present.

Such an ideal gas would result from the burning of equal weights of air to CO_2 and CO, the composition of the gas being:—

CO_2	CO	N_2	Ratio CO_2/CO
Per cent.	Per cent.	Per cent.	Per cent.
18.8	9.4	71·8 by volume	2.0
17.8	14.0	68.2 by weight	1.27 (a)

The upper two or three rows of auxiliary tuyeres are so proportioned that such a gas can be supplied with the additional air necessary for progressively converting the CO to CO_2 within the depth of the coke bed.

In designing the balanced-blast cupola and, later, in determining the method of operating the furnace, the writer has attempted to carry out his original conception of so controlling the air supply to the main row of valved tuyeres that the gases in the lower half of the coke bed, where superheating of the metal and slag takes place, are poorer in free oxygen than is the case in the ordinary cupola. Wüst in Germany, and Belden, Kinney, Royster and Joseph in U.S.A., had proved that in the outer half of the cupola or blast furnace, adjacent to the main tuyeres, the gases are highly oxidising in character and detrimentally affect the iron dripping through this zone.

In practice the hearth gases in the balanced-blast cupola generally differ from the neutral gas of the analysis (*a*), but, by adjusting the main air-control valves the gases can be made to approach the composition shown below (at *b*), containing sufficient CO to preclude the presence of any serious percentage of free oxygen.

CO_2	CO	O_2	N_2	CO_2/CO
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
15.9	8.0	0.2	75.9 by volume	1.99
22.9	7.3	0.2	69.6 by weight	3.14 (b)

Any serious restriction of air at the lower-valved tuyeres can produce gases of type (*a*), whilst a more liberal supply will encourage the production of gases of type (*b*).

The nearer the gases in the lower-tuyere zone approach the neutral condition, analysis (*a*), the greater must be the air supply through the auxiliary tuyeres to effect the desired complete combustion of the coke carbon to CO_2 within the coke bed.

Mr. Neville is quite correct in assuming that the use of the air-control valves at the lower main tuyeres enables the balanced-blast cupola to work along the lines of variation β, the aim being to lower the horizon of the oxidising zone. Other variations involving an excessive supply of air through the main tuyeres are avoided by the use of the control valves.

The quality of the coke has an influence on the level of the zone of maximum temperature in the superheating portion of the coke bed, and here again the balancing of the two supplies of air through the main and auxiliary tuyeres by means of the valve adjustments is important.

In dealing with the six points in Mr. Neville's letter the following give the writer's conclusions:—

(1) The gas paths are admittedly in the directions shown in Fig. 1 and there is a lapse of time before the air entering the coke bed from the tuyeres can be converted to CO or CO_2 in any cold-blast furnace. But, if the air streams leave the tuyere mouths at a sufficiently high velocity and carry an optimum weight of air per second two desired conditions are fulfilled:—

(*a*) The air is more rapidly carried horizontally towards the centre of the coke bed before taking the vertical ascent, and (*b*) the rate of coke consumption in the central half of the cupola cross-section is increased and the tendency for the gases to hug the outer half is diminished. Here, particularly in the ordinary cupola, is an annular zone of high temperature traversed by oxidising gases and in which the maximum rate of melting (per sq. ft. of cross-sectional coke-bed area per hour) occurs.

(2) The variation marked β in Fig. 2 is used in the balanced-blast cupola, the inflow velocity being kept constant, with the air volume controlled by the valves in accordance with the desired minimum of coke consumption—the higher the practicable metal to coke ratio the lower the coke consumption and the smaller the weight of air used per ton of iron melted.

(3) Little, if any, oxidation difficulties have been traced to the impingement of air from the auxiliary tuyeres.

(4) The time factor plays an important part in the process of securing the completion of combustion. The deeper coke bed gives space for each step in the provision of additional air to burn the remnant of the CO in the gases as they reach, progressively, the higher levels of the auxiliary tuyeres. The highly-incandescent coke bed is the flywheel of the system, assisting the diffusion of the hot gases throughout the bed, and providing a heat storage against the many interferences which often prevent "non-stop" melting during a day's blow.

(5) The proper apportionment of the volume required in the cupola for the coke bed and preheating zone has been seriously considered in designing the balanced-blast cupola. Low top-gas temperatures are only possible in properly-designed furnaces, provided with suitable blowing equipment, and carefully operated. In these critical days it is positively painful to find, in so many foundries, lack of charge-weighing and recording appliances, and of that detailed attention to the melting unit which must always be an important index to foundry efficiency. If the top-gas temperatures are low and the CO content lower than 5 per cent. by volume, one cannot expect carbon deposit due to the low velocity of the gases during the reaction $2CO \rightarrow CO_2 + C$.

As the top-gases from the ordinary cupola are often of nearly the same analysis as those from the top of the coke bed—the same result being also found in balanced-blast practice—the above reaction can scarcely be expected to take place. The greatest losses in the thermal efficiency of cupola melting may be traced to the reaction $CO_2 + C \rightarrow 2CO$ in the coke bed, and, in the balanced-blast cupola, where additional oxygen is supplied in the zone where the above reaction occurs in ordinary cupolas, there must be little opportunity for the CO content in the gases to increase simultaneously with an increase in CO_2. The high temperature of the deep coke bed and the low temperature of the top-gases point to a high efficiency in the mechanism of combustion within the coke bed, giving possibilities in the direction of greater economies than have yet been reached.

(6) Many estimates of the ratio

$$\frac{\text{weight of air blown}}{\text{weight of coke burnt}}$$

have been made, based on air-volume measurements and total coke weighed, during melts of varying duration (taking account of bed coke and coke rescued from the "drop"). The air-weight deduced from the volume measurement in the most careful experiments made so far did not compare satisfactorily with the result expected from the fan data (volume per minute supplied at recorded outlet pressure).

From the analysis of top-gases recorded in a recent test, the estimated weight of air per lb. of carbon in the gases was 10.8 lbs., the analysis of the gas being as under:—

CO_2	CO	N_2	CO_2/CO	
Per cent.	Per cent.	Per cent.	Per cent.	
20.6	1.4	14.7	14.7	by volume
28.90	1.25	69.85	23.1	by weight

Taking the carbon content of the Durham coke used at 93 per cent. the weight of air used per lb. of coke was 10.05 lbs. These results are typical of the best results yet recorded and actually refer to a 3-hr. blow with a 54-in. bore balanced-blast cupola, the melting rate of which is usually 12 tons per hr., but was melting at 11.2 tons per hr. during the recorded melt.

As the aim of the writer has been, in the development of the balanced-blast system of air control, the complete combustion of the coke carbon to CO_2, the estimated weight of air allowed per lb. of coke carbon is 11.6 lbs. or 10.4 lbs. air per lb. of coke of 90 per cent. carbon content, allowance being made for the varying demands due to different durations of the blowing time, intermittent melting periods and stoppages, etc.

With thanks to Mr. Neville for his suggestive letter, and to the British Cast Iron Research Association for their invaluable help during the development of the balanced-blast cupola.—Yours, etc.,

I. E. Fletcher.

Netherton Iron Works, Dudley.

[It is pleasing to learn from Mr. Fletcher's covering letter that though still confined to his home, he takes a live interest in all foundry developments. We thank Mr. Fletcher for his interesting contribution to the subject and wish him a speedy recovery from the very serious illness he has had.—Editor.]

British Students to Tour Belgium

To the Editor of The Foundry Trade Journal.

Sir,—The first educational tour to be arranged by the Institute of Metals for its student members begins next week. On Sunday morning, April 8, a party of over 40 young men will leave Victoria Station, London, *en route* for Belgium. The party will spend April 9 and 10 in Liége and district visiting, *inter alia*, the works of Ste. Ame. John Cockerill; Ste. Ame. d'Ougrée Marihaye; Ste. Ame. des Mines et Fonderies de Zinc de la Vieille-Montagne, and Fabrique Nationale d'Armes de Guerre.

In the evening of April 10 the students will travel to Charleroi and on the next day visits will be paid to Ateliers de Constructions Electriques de Charleroi and Ste. Ame. des Laminoirs, Hauts Fourneaux, Forges, Fonderies et Usines de la Providence. On April 12 the party is due to leave Charleroi for Brussels, where the day will be spent in seeing the Belgian capital and in visiting the University. Leaving Brussels

(*Concluded on page* 232)

The Use of Sodium Carbonate in Iron and Steel Works*

By N. L. Evans, B.Sc., A.I.C.

Introduction

Sodium carbonate, which is the anhydrous form of the familiar washing soda, is a chemical which has recently attracted a considerable amount of attention in this country as a cleansing flux and desulphurising reagent for cast iron and certain non-ferrous metals. It melts at 851 deg. C. and does not volatilise too rapidly for use until it is heated to 1,450 deg. C. or more. It therefore has a useful range of about 600 deg. C. when used as a flux, within limits, which include copper, brass, bronze and cast-iron melting.

The present Paper refers briefly, for the sake of completeness, to the methods of using sodium carbonate in the foundry, but these have been dealt with more fully elsewhere.[1] More particular attention is therefore given here to some of the more important applications and recent developments of the process, together with applications which are still in the experimental stage, but offer considerable prospect of working economies and improved results, if they can be developed successfully on a full scale.

Description of the Sodium Carbonate Process

Sodium carbonate is supplied in two forms for use in the iron and steel industry. The most important is granular ash, and the other fused blocks. Granular ash is an improved form of sodium carbonate, which is practically free from dust. Only about 5 per cent. will pass a 150-I.M.M. sieve, instead of over 21 per cent., in the grade which used to be supplied to foundries. This results in much greater efficiency, as dust is to a large extent lost when treating cast iron, owing to the rapid evolution of gas which takes place. In conjunction with granular ash, ground limestone is used to thicken the soda slag and make it easy to rake off. Fused blocks of sodium carbonate, weighing 4 lbs. each, are supplied for use as a cupola flux, or wherever a strong current of gases is passing, which would blow the granular carbonate away.

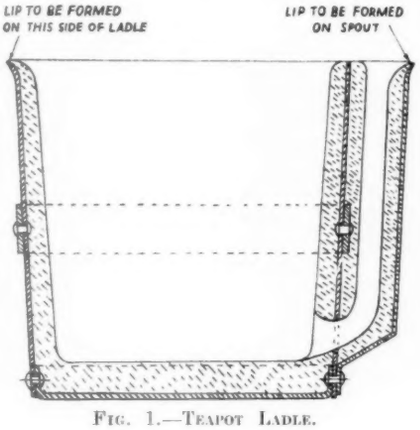

Fig. 1.—Teapot Ladle.

Ladle Treatment

Dealing first with the ladle treatment, with granular ash, this can be carried out in one of two ways. In cases where the maximum possible sulphur reduction is desired, as for steelmaking or refined pig-iron, the sodium carbonate is put in the bottom of the ladle in the proportion of 1 lb. for each 1 cwt. of iron to be treated, and the iron from the cupola, blast furnace or mixer is tapped on to it, in one or several stages, as the particular case demands. The sodium carbonate rapidly melts, producing a highly-fluid slag from which carbon dioxide is evolved, resulting in an active "boil." The agitation thus produced, together with the stream of metal entering the ladle, thoroughly mixes the slag and metal, so that the chemical reactions by which sulphur is extracted from the metal have every opportunity of taking place, and gases in supersaturated solution are released.

When the ladle is full, a short time is allowed for the slag to rise to the surface, where it is thickened by the addition of ground limestone, of which ¾ lb. is required for each 1 lb. of sodium carbonate used. The limestone should not be simply thrown on to the slag. It needs to be well rabbled into it, producing a dry, lumpy clinker which can be readily raked off, leaving perfectly clean metal ready for pouring. This method has been successfully used with quantities of iron up to 25 tons, and there is no reason why even larger quantities should not be dealt with.

But when using small ladles it is sometimes not possible to wait while the limestone is added and rabbled in, either because the delay interferes with the foundry routine or because a small bulk of metal loses heat comparatively rapidly while standing. To meet such conditions a modified technique has been evolved which, while not quite so efficient in removing sulphur, gives all the other benefits of the treatment, and involves scarcely any delay. The sodium carbonate is first mixed with the required quantity of ground limestone (the proportions being the same as those previously given) and the mixture is put into the ladle before tapping. By these means the slag, which should be stirred while the ladle is filling, is ready for raking off as soon as the full quantity of iron has been tapped.

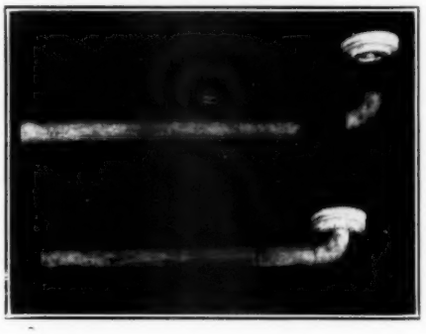

Fig. 2.—Templates for the Ramming-Up of the Spout.

Teapot Ladles and Forehearths

It is in this matter of speeding up the process that the most notable advances have recently been made. In a Paper presented over a year ago on this subject,[2] reference was made to the advantages of teapot ladles and forehearths in connection with sodium-carbonate treatment. It is now possible to report that both these items of foundry equipment are being more widely adopted, with highly-beneficial results.

Dealing first with the teapot ladle, it is fairly obvious that a ladle embodying any kind of syphoning principle, whereby metal is drawn from the bottom, is likely to deliver cleaner metal to the mould than the usual type of ladle, which, in spite of the use of skimmers and stoppered-runner boxes, is likely to allow any foreign matter floating on the surface of the metal to pass into the mould. The teapot principle is now being used to obviate the need for very careful skimming of the soda-ash/limestone slag.

Fig. 1 shows a section of one such ladle, in which a teapot spout is fixed on the outside of the ladle. The spout is lined by ramming the lining material round a wooden core, made in three pieces to facilitate its extraction (Fig. 2). Fig. 3 is a picture of an actual ladle of this type, having about 10 cwts. capacity. The same result can be obtained by fixing inside the ladle a partition, perforated at the bottom; this being probably a little easier to daub.

In using such ladles, sufficient iron is tapped to seal the bottom of the spout, and the mixture of sodium carbonate and ground limestone is then thrown in, in a paper bag or from a measure of suitable size. When the ladle is full, the slag can be immediately raked off and the metal is ready for pouring.

A still better method of working in mass-production foundries is to use a suitably-designed forehearth or receiver. Many forehearths are not adapted for the application of sodium carbonate, as they are used as preheaters for the cupola-air blast, and, consequently, must be kept closed at the top. However, a well-known motor manufacturer in this country has now installed receivers, which are in every way suitable (Fig. 4). A permanent opening is left in the roof through which soda ash can be introduced, and a continuous stream of metal flows into the receiver through a slag trap. In the connecting launder between the cupola and receiver is inserted a perforated brick. The entrance to the receiver is above the level of the cupola taphole, so that it is almost impossible for cupola slag to get into the receiver. The importance of this will be shown later on. The use of ground limestone is unnecessary, as there is no advantage in thickening the slag, so that the maximum desulphurising action takes place. Less sodium carbonate is needed, as slag always remains in the receiver and simply needs small additions from time to time to maintain its activity. The full proportion of sodium carbonate (1 lb. per hundredweight of metal) should be used for the first receiverful of metal in the day's run, and after that ½ lb. per hundredweight will probably suffice to maintain a good desulphurising reaction.

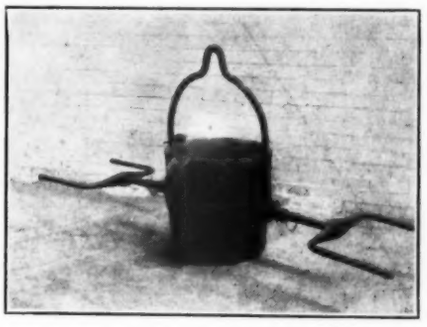

Fig. 3.—A 10-cwt. "Teapot" Ladle.

Chemical Reactions

The chemical reactions of the sodium-carbonate process are probably very complicated, and, as is the case of the heat reactions, it is impossible to give the complete story. It can be said definitely, however, that part of the sulphur from the metal is retained in the slag, and part of it is evolved as sulphur dioxide, which can invariably be detected by smell during the course of the process.

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen.

1 See the Foundry Trade Journal, April 30, 1931, December 1, 1932, December 22, 1932, January 5, 1933, October 5, 1933.

2 Foundry Trade Journal, December 1, 1932, pp. 331-337.

The following equations probably represent the principal reactions:—

(1) $Na_2CO_3 + \frac{MnS}{FeS} = Na_2S + \frac{MnO}{FeO} + CO_2$

(2) $Na_2S + MnO + FeO + Na_2CO_3 = Na_2O + Mn + Fe + SO_2 + CO$

(3) $Na_2CO_3 = Na_2O + CO_2$

(4) $Na_2S + SiO_2 + \frac{MnO}{FeO} = Na_2O.SiO_2 + \frac{MnS}{FeS}$

(1) is the main desulphurising reaction, resulting in the formation of sodium sulphide which can be detected in the slag.

(2) explains why the manganese content of treated metal is often higher than that of the same metal before treatment. Manganese sulphide which would normally float to the surface of the bath and be lost as slag is reduced to metallic manganese which goes back into the melt.

(3) is the simple dissociation of sodium carbonate which is responsible for the evolution of carbon dioxide and the agitation of the melt.

(4) illustrates the harmful action of silica, which reacts to form sodium silicate and reforms manganese sulphide or iron sulphide. This silica may have its origin in cupola slag which is allowed to escape, old slag adhering to the ladle sides, or attack on the refractory lining.

Fig. 4.—Specially-Designed Receiver adapted for Using the Soda-Ash Process.

Sulphur Removal

Some actual examples of the amount of sulphur removed will serve to emphasise the importance of carrying out the reaction in the absence of siliceous slag. Table I gives typical results when sodium carbonate alone is put in the bottom of the ladle, and the slag so formed is subsequently thickened with ground limestone. The sulphur reduction varies from about 30 per cent. to nearly 60 per cent. Even greater reductions have frequently been obtained when contact between metal and slag has been prolonged, but the figures quoted may be taken as average results.

Table I.—*Sulphur Reduction. Typical Results, using Separate Additions of Sodium Carbonate and Ground Limestone.*

Untreated.	Treated.	Sulphur reduction.
Per cent.	Per cent.	Per cent.
0.13 S	0.062 S	52
0.08	0.05	37
0.104	0.048	54
0.091	0.063	31
0.10	0.043	57
0.076	0.040	47

Table II gives results when the sodium carbonate and ground limestone are mixed before use. Owing to the reduced fluidity of the slag, the greatest reduction is only about 45 per cent. of the sulphur—which, however, is a very useful amount to remove, but as little as 18 per cent. was removed in one case.

Table II.—*Sulphur Reduction. Typical Results, using a Mixture of Sodium Carbonate and Ground Limestone.*

Untreated.	Treated.	Sulphur reduction.
Per cent.	Per cent.	Per cent.
0.144 S	0.096 S	33
0.116	0.078	33
0.106	0.087	18
0.10	0.055	45
0.11	0.085	23
0.072	0.053	26
0.136	0.077	43

The irregularity of these results is due to the fact that cupola slag is frequently allowed to run into the ladle, so that sodium silicate is formed and sulphides of iron and manganese are allowed to re-enter the bath, in accordance with equation (4) above. That this is so seems evident from the next series of results (Table III) representing experiments on mixer metal which was treated with sodium carbonate before being transferred to the basic open-hearth furnace. When the mixer is tilted the iron is poured into the ladle from below the slag line, so that it is free from siliceous matter. It will be seen that, in spite of the initially-low sulphur content, and the fact that the temperature was higher than that of the cupola metal, the sulphur reduction was about 50 per cent. in every case.

Table III.—*Metal from 500-ton Mixer treated with Sodium Carbonate before Charging to Basic Open Hearth Furnace.*

	P.	Mn.	Si.	S.
Before ..	0.994	1.708	1.809	0.024
After ..	0.931	1.720	1.715	0.012
Before ..	0.952	1.748	1.880	0.020
After ..	0.952	1.773	1.740	0.010
Before ..	0.966	1.773	1.857	0.019
After ..	0.966	1.786	1.725	0.010
Before ..	0.910	1.436	0.982	0.021
After ..	0.910	1.486	0.868	0.012
Before ..	0.925	1.488	1.062	0.020
After ..	0.925	1.500	0.893	0.009
Before ..	0.972	1.451	1.001	0.030
After ..	0.960	1.463	0.836	0.013
Before ..	0.960	1.525	1.057	0.022
After ..	0.960	1.550	0.893	0.011
Before ..	0.937	1.512	1.034	0.021
After ..	0.937	1.525	0.912	0.010
Before ..	0.966	1.562	1.104	0.021
After ..	0.952	1.575	0.994	0.012

(It may be remarked here that a high temperature, say 1,450 deg. and upwards, tends to make desulphurisation less efficient, on account of the loss of sodium carbonate by volatilisation.)

Fused Sodium-Carbonate Blocks

Turning now to a consideration of fused sodium-carbonate blocks, these, or similar materials, have been comparatively well known for some years. "Walter" briquettes, which

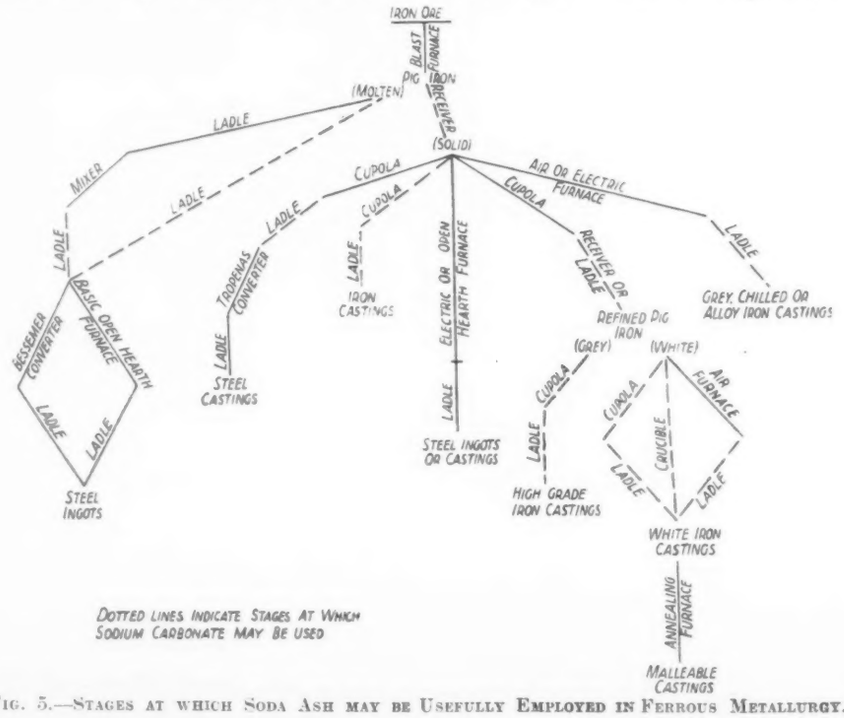

Fig. 5.—Stages at which Soda Ash may be Usefully Employed in Ferrous Metallurgy.

attracted a certain amount of attention a short time ago, are said to contain 90 per cent. sodium carbonate, and the American product "Purite" is pure sodium carbonate.

In some cases where very small ladles or hand shanks are filled direct from the cupola spout and there is no time available for de-slagging, as for example when making white-iron castings for malleablising, then fused sodium carbonate may be added to the cupola charge with the limestone. As in the case of the receiver, where the soda slag is partly retained, a smaller quantity of sodium carbonate is required, namely, 1 lb. per 1 cwt. of iron for the first charge and ½ lb. per 1 cwt. for subsequent charges, though in special cases larger quantities are used. The advantages of the process are the production of a more fluid and more active slag, which gives remarkably clean metal, and the cupola walls are kept free from slag. This is a point to which further reference will be made later on, when dealing with refractories. As regards desulphurisation, this is only effected if the slag is kept sufficiently basic, and it is often found that the amount of limestone used in the cupola is insufficient for this. But although sulphur may not actually be removed, pick-up from the coke can certainly be prevented. To get actual desulphurisation in the cupola the slag should contain at least 28 or 30 per cent. CaO.

Another interesting effect has been noticed in one foundry, namely, that cupola additions of sodium carbonate tend to reduce the total carbon content of the iron. This is mentioned with a certain amount of reserve, as it has only been reported by one user. Any further confirmation will be received with great interest. Cupola treatment has been found to give very satisfactory results in the case of malleable iron, the types of unsoundness to which white iron is susceptible being reduced to a marked extent.

For black-heart malleable, however, the best results are obtained by making a desulphurised pig-iron which can be treated in a ladle or receiver, as it is essential in this process to

Fig. 6.—Typical Defect to be Associated with Section Change.

have a much lower sulphur content than is usual in white-heart malleable iron. In America, where it is usual to melt in an air furnace for black-heart malleable, a sodium-carbonate slag is formed in the furnace, and it is claimed that, in addition to controlling sulphur, it shows a saving in fuel, as it speeds up slag separation from the melt.

Action on Refractories

A considerable amount of experience has now been accumulated on the effects of sodium-carbonate slags on refractories. So far as ladles are concerned, no special lining materials are necessary. The usual foundry daub, brushed over with blacking, is perfectly satisfactory, for small ladles. Large ladles are usually brick lined and, provided the joints are kept as thin as possible, no trouble need be anticipated. One firm is getting excellent service from a rammed-ganister lining, into which is milled from 5 to 10 per cent. of plumbago. This mixture is rammed into position round a core, the ramming being done as hard as possible, with the mixture as dry as

Fig. 7.—Unetched Structure of Ordinary Grey Iron showing MnS Inclusions.

possible, consistent with sticking. Such a lining, about 2 in. to 2½ in. thick, lasts for 150 to 200 heats of metal treated with sodium carbonate.

The glazing action of the soda slag appears to protect the lining from further rapid attack. If the mixture of sodium carbonate and ground limestone is used, attack is still less noticeable and the ladle is kept remarkably clean. When very large ladles are in use, as for transporting metal from a mixer to an open-hearth furnace, a considerable saving results from the fact that the formation of skulls is prevented by the heat insulation of the slag, and the normal capacity of the ladle is maintained.

It is important, when using the process, to start with a clean ladle. A ladle which has been used previously probably has a certain amount of cupola slag adhering to the walls, and this may be dissolved off by the soda slag and keep floating up to the surface.

When fused blocks are used in the cupola the walls are kept unusually clean, so that the amount of patching required is very small. There are practically no large adhering lumps of slag to be chipped away, damaging the lining, and the saving in ganister alone is considerable. Of course, in a badly-bricked cupola, with wide joints, trouble is only to be expected, but if the lining has been well built in, the use of sodium carbonate will improve conditions and reduce costs.

Applications

In dealing with the applications of the sodium-carbonate process, the best method probably is to deal with the more important products and point out the particular advantages of the process to each product. Fig. 5 indicates the stages at which sodium carbonate may be used, from blast furnace to finished products.

Grey-Iron Castings

Perhaps the two most necessary features of grey-iron castings are soundness and machinability. The numerous specifications which include tensile strength are of little real use, as test-bars can seldom be designed to give a true representation of the properties of the casting. But few things are more annoying or more expensive than to run into a spongy place in a casting when machining is almost completed, or to find that a finished casting leaks under hydraulic test or in service, so that any steps which can be taken in the foundry to ensure soundness will repay amply the extra trouble involved. Unsoundness which is the result of defective moulding and suchlike faults cannot, of course, be remedied by sodium carbonate, but the formation of shrinkage cavities can be controlled to a very great extent. It is believed that such cavities bear some relationship to gas in cast iron. Defects of this type, of which Fig. 6 is an example, are likely to occur at changes in section of the casting. The one shown is at the junction of a pipe with its flange. A similar effect is sometimes found when the graphite is abnormally coarse, on account of the total carbon or silicon contents being too high. Another type of cavity is obviously due to the evolution of gas when the metal is pasty, and the bubbles which are formed are trapped, so that the top of the runner does not sink in, but remains more or less flat, after the style of a rimming steel ingot. Both these kinds of cavity can be minimised if not entirely prevented, by degasifying the metal in the ladle by rapid agitation, such as is produced by the evolution of carbon dioxide from sodium carbonate. For example, in one foundry making cast-iron pipes the use of chills in the radius between a pipe and its flange has been done away with up to 6-in. dia. pipes, and the number of rejects on hydraulic test is less than it has ever been.

The elimination of such rejects becomes still more important in the case of castings for chemical plant, particularly those used at elevated temperatures. It is well known that a casting with a serious cavity may show no signs of the trouble under a simple pressure test, but when any corrosive chemical comes into contact with it, it is rapidly perforated. Apart from the inconvenience of failures of this type, they may expose workmen to serious danger. In a chemical works it has been found, after an extensive experiment that certain large cast-iron vessels have worn away much more evenly, and have an improved life, when they have been treated with sodium carbonate. Failure due to pitting is much less common than used to be the case. Pitting is probably due, in many instances, to preferential corrosion, due to sulphur segregations. In another type of casting subjected to a temperature of probably 700 deg. C. on the outside, an increase in life of the order of 25 per cent. has been obtained. It may be assumed that this is partly due to the castings being sounder and partly to the refined graphite produced by sodium-carbonate treatment. This is another very distinctive result of the process. In a thick section the centre is found to be much closer and the structure more even in treated than in untreated metal. Fig. 7 is a typical structure of an ordinary foundry iron, with a sulphur

Fig. 8.—The same Iron as Fig. 7 after Treatment by the Soda-Ash Process.

content of 0.092 per cent. Numerous inclusions of manganese sulphide are present. In Fig. 8 is shown the same iron after treatment (with mixed sodium carbonate and limestone), the sulphur having been reduced to 0.058 per cent. Not only are the inclusions reduced in size and number, but the graphite is refined to a marked extent. There is no doubt that the elimination of sulphide inclusions, which have such a tendency to segregate, helps to improve the corrosion resistance of the metal.

Ingot moulds have been successfully treated with sodium carbonate, and have given an increase of 7 to 10 per cent. in life as compared with untreated moulds. A further saving resulting from the process in the case of heavy castings is in the reduced time necessary for the tedious process of "feeding."

Rolls

It is only natural that there should have been some difficulty in persuading foundrymen to experiment with important and expensive castings, and chilled rolls are a good example of this. But, starting with small trials, which have given encouraging results, the stage has now been reached where rolls up to 4 or 5 ft. long have been treated. Fig. 9 is a picture of a mill for rolling copper sheet, in which two such rolls are working. After six weeks' use, the surface was stated to be superior to that of ordinary rolls, both in smoothness and hardness. The belief is strongly held by some roll founders that a high-sulphur content is desirable, and increases the hardness of rolls. It would seem more reasonable, however, to control the hardness by the silicon content of the iron, that is, by an element which has none of the undesirable tendency to segregate, which is shown by sulphur. Actual experiments have proved that hardness

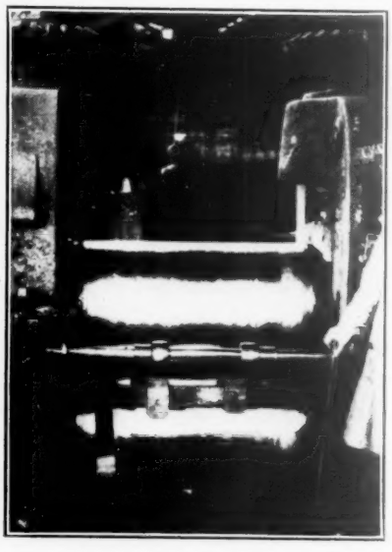

Fig. 9.—The Soda-Ash Process has been Used in the Production of this Pair of Rolls.

need not be sacrificed if sulphur is reduced to a low figure.

Fig. 10 shows sections across two small rolls, one being untreated and the other treated. The internal cavity which occurs in the untreated one has been entirely eliminated by sodium carbonate.

Steel Castings

In the manufacture of steel castings by the Tropenas process, the production of a metal low in sulphur is essential, and a method by which that element can be removed not only improves the quality of the castings but effects considerable economies by giving a much wider choice of raw materials. Mixtures containing high percentages of scrap are being successfully melted and converted to steel, and the quality of the resulting castings is not in any way sacrificed. For example, mild-steel castings are produced with a tensile strength of 38.4 tons per sq. in. and 25 per cent. elongation on 2 in., with a bend test of 180 deg. after annealing. The British Standard Specification for this material demands only 35 tons per sq. in. and 15 per cent. elonga-

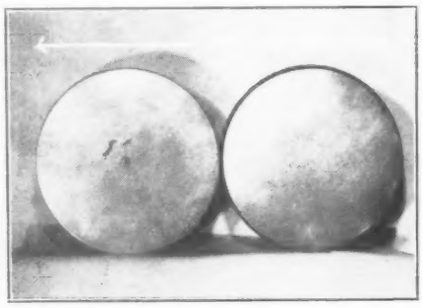

Fig. 10.—Section of Two Small Rolls. The one on the right has been treated with Soda Ash.

tion, with no bend test. Fig. 11 illustrates the test-pieces in question.

Sulphur removal is not the only factor responsible for these results, though it is important enough, in view of the sulphur pickup in the cupola and the concentration of this element which occurs in the converter. It is considered that the scavenging action of the soda slag, when the cupola metal is being treated, results in the removal of entrained oxides and silicates, and helps to give the finished steel its excellent ductility.

Bessemer Steel

In the Bessemer-steel process, whether acid or basic, the use of sodium carbonate offers a ready means of reducing the sulphur, by treating iron in the ladle in which it is transferred from the blast furnace or mixer to the Bessemer converter. If siliceous slag be kept out of the ladles, the process is very efficient with such a large bulk of metal.

Basic Open-Hearth Steel

The same remarks apply to the manufacture of basic open-hearth steel when liquid metal is charged to the furnace. Figures have already been quoted showing the remarkably low sulphur contents which can be obtained.

Many steelmakers appear to be most anxious to keep the sulphur content low in basic steel which is used for steel sheet. It is stated that the cavities in a non-killed ingot will weld up perfectly on rolling if the sulphur content is not above 0.03 per cent., but above this figure trouble is sometimes experienced. But if sulphur has to be removed in the last stages of the steelmaking process, after the rest of the impurities are sufficiently reduced, the metal has to be kept in the furnace about half an hour for each 0.01 per cent. of sulphur to be eliminated. It would seem, therefore, that the cost of preliminary treatment with sodium carbonate would pay handsomely.

A further development which may prove to be of considerable importance, but is so far only in the early experimental stage, is the possible use of fused sodium carbonate blocks in the basic open-hearth furnace. It is suggested that the blocks might be put in with the cold pig-iron charge, and the slag thus formed would react with the iron as soon as it melted. As an alternative, the iron might be treated with sodium carbonate as it leaves the blast furnace before it is pigged, but the disadvantage of this would be the subsequent pick-up of sulphur from the producer gas, which would not be so likely to take place in the presence of soda slag.

A considerable number of full-scale experiments have been carried out in America by Lowry,[3] who used sodium carbonate to replace part of the fluorspar addition to the molten bath in the basic open-hearth furnace. He tried various other mixtures such as salt and sodium carbonate, but sodium carbonate and fluorspar gave the best slag from the point of view of consistency and desulphurisation. This was believed to be due to the formation of sodium fluoride, which, when added as such, appears to be ideal, but is ruled out on grounds of cost.

An interesting possibility in connection with the replacement of fluorspar by soda ash is its effect on the value of the slag as a fertiliser. Stead and some of his collaborators have shown how rapidly fluorspar additions lower the solubility of phosphate in citric acid. If sodium carbonate can be used in place of part or the whole of the fluorspar, the proportion of available phosphates should be materially increased, thus increasing the selling price of the slag.

Catalytic Action of Sodium Carbonate

There are two catalytic effects of sodium carbonate which are of interest to the iron and steel industries, although they do not yet appear to have been developed on a commercial scale. The first is the effect noticed by Williams and Ragatz, that sodium carbonate accelerates the rate of reduction of iron ores. This might find application in the blast furnace or in some of the processes now in course of development for the low-temperature reduction of iron ore to form sponge iron.

The second effect, described by Prof. Cobb in this country and by other workers in America, is the acceleration of the rate of decomposition of steam by carbon and the rate of reduction of carbon dioxide by carbon. In making producer gas, the capacity of a producer could be increased if sodium carbonate were used, owing to the shorter contact time required; and the gas should contain less undecomposed steam and carbon dioxide and more carbon monoxide and hydrogen.

Non-Ferrous Metals

Although strictly speaking it is outside the scope of this Paper, brief mention may be made

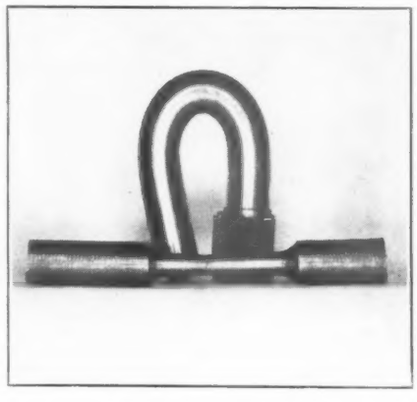

Fig. 11.—Test-Pieces from a Treated Mild-Steel Casting showing 38 tons Tensile and 25 per cent. Elongation.

of the use of sodium carbonate in non-ferrous foundry practice. The fluxes used in non-ferrous melting have been shrouded in the deepest mystery, and very little scientific basis appeared to exist for their application. But a recent Paper by Tyrie[4] has shed a considerable amount of light on this subject, particularly regarding the melting of brass and bronze swarf. Tyrie points out that deoxidation of such materials is usually necessary, and the oxides formed as a result of this need to be removed. The speed of their separation from the metal bath is dependent on their particle size, large particles floating to the surface easily. It is desirable, there-

(*Concluded on page 232*)

[3] Trans. Am. Soc. Steel Treating, Vol. 10, 1926.

[4] "Fluxes and Slags in Non-Ferrous Foundry Practice." Thos. Tyrie. "The Chemical Age," February 3, 1934, pp. 9-11.

The Potentialities of Cast Iron

By A. B. Everest, Ph.D.

(*Concluded from page* 210.)

Hard White Irons

Considering further the question of heat-treatment of castings, the effect of heat-treatment on a grey iron is to produce a material with a hardness generally round about 400 Brinell, and which consists of a martensite matrix broken up by the usual graphite flakes. Harder structures are, of course, available in the white irons, in which the graphite is replaced by massive carbides, the matrix of the metal consisting of pearlite under ordinary conditions. Just as the grey irons are amenable to heat-treatment and hardening by the use of alloys, so recent developments have shown that the white irons can similarly be treated and that, whereas the hardness of an ordinary white or chilled iron is somewhere in the region of 500 Brinell, by the use of heat-treatment or of sufficient alloys, such as nickel and chromium, to give air-hardening compositions, the hardness of the iron may be increased to figures corresponding to 700 or 800 Brinell (Fig. 4).

Fig. 4.—Typical Microstructure of "Ni-Hard" Cast Iron. The Micro shows Massive Carbides (White) set in a Martensitic Matrix.

These new hard white irons are of special interest in connection with such applications as chilled-iron rolls, where it has been found that, by suitable combinations of alloys, the hardness of the rolls may be not far short of that obtained in the best alloy steels. A point of outstanding interest, however, in this connection is that, in spite of their slightly lower hardness, the alloy-chilled-iron rolls are in many respects superior in their service qualities to the more expensive steels. The rolls possess a greater power to grip the work passing through them, so that actually heavier pinches become possible, but, what is perhaps even more important, is that the rolls resist surface formation and are superior to steel in the absence of such troubles as tail-marking.

These new hard white irons are also of very great interest in many applications encountered in mining equipment, crusher rings and rollers, crusher balls and other similar parts being found to give exceptionally long life in this type of iron. With regard to actual abrasive wear, it is found that the parts are in some cases even superior to manganese steel, although, of course, it must not be overlooked that the chilled iron does not possess the inherent toughness of the steel and cannot, therefore, be used where excessive shock is encountered. There are, however, many applications where these white irons are already proving successful, these including, in addition to the above, pumps, pipes and fittings for gravel dredgers and equipment handling sandy water. There is no doubt that, as these irons become better known, they will find even wider application in general engineering practice.

Whilst referring to the question of hard abrasion-resistant irons, passing reference must be made to the process of nitrogen hardening whereby iron castings can be given a surface hardness corresponding to a Brinell figure of about 1,000. This process enables cast iron to be given an exceedingly hard, wear-resistant surface, although in view of the thinness of the skin produced, it is clearly not suitable for such heavy-duty parts as rolls.

Austenitic Cast Irons

The general features of the austenitic cast irons have been described too frequently to need repetition here. It is sufficient to say that considerable progress has been made in the past two or three years in the application of the austenitic irons for corrosion-resisting service, as, for example, in pumps, pipes and fittings handling sea water and in the chemical industry.

In the electrical industry also the austenitic irons continue to make progress in applications where non-magnetic castings are required. In switchgear the austenitic irons are proving superior even to welded-steel structures which, in spite of their cheapness, fail owing to their magnetic qualities which cause losses, and inaccuracies in the metering instruments. It is perhaps in the field of heat-resistance, however, that most progress has been made.

Heat-Resisting Cast Irons

The advantages of the austenitic irons over unalloyed materials in resisting growth and oxidation are well known but, for a heat-resisting alloy, further properties are required, the most important of which is resistance to creep or gradual deformation under load whether at low or at elevated temperatures.

Recently, investigators have proved that, in resisting deformation, cast iron shows advantages over many of the other metals and that, at temperatures up to 300 deg. C. at least, the irons will stand a load of about 75 per cent. of their breaking load without showing any measureable deformation after protracted periods of time.

This feature, coupled with the good oxidation and growth resistance of the austenitic irons, opens up still further possibilities for these materials in heat-resisting applications, showing that, even under quite severe load, the irons may prove superior even to the much more expensive non-ferrous or ferrous heat-resisting alloys.

Expansion Characteristics

Another property which is now coming to the fore in connection with cast iron is its expansion. As is well known, austenitic irons have a high expansion of about 18 millionths per deg. C. as compared with about 12 millionths per deg. C. for the ordinary materials. This high expansion of the austenitic irons is in some cases a serious disadvantage but, in other cases, it is proving of definite value in modern engine construction.

The tendency in the construction of automobile and aero engines is to use to an ever-increasing extent the aluminium and light alloys for engine blocks and heads, etc. Aluminium is, however, totally inadequate as a wear-resistant material, and aluminium engines must be fitted with steel or cast-iron liners or other parts where wear or impact is liable to take place.

Aluminium is, however, also characterised by a very high thermal expansion and consequently, in parts subjected to fluctuating temperature, serious difficulty is liable to arise with the differential expansion of the different components. An interesting example of the method in which the modern cast irons have helped the engineer in the solution of his problems is in connection with high-speed Diesel-engine pistons. The sketch, Fig. 6, shows a modern Diesel-engine piston cast in an aluminium alloy. It has been found, however, that at the operating temperature of the piston the metal is seriously softened and widening and deformation of the piston-ring grooves result. This widening of the grooves leads to looseness and tilting of the piston rings, with the ultimate result that cylinder wear is seriously aggravated. In the development as shown, Mahle[6] developed a piston

Fig. 5.—"Ni-Resist" Corrosion-Resisting-Cast Iron Valve as used in the Chemical Industry handling Sea-Water, etc.

in which a cast-iron ring was included in the piston in such a position that the ring grooves for at least the two top rings are cut in the iron, thus providing hard permanent grooves which are capable of resisting the temperature attained in the cylinder.

Ordinary cast iron was first tried out for this application, but the wide difference in expansion between it and the aluminium led to excessive trouble and failure. The problem has now been solved by using the high-expansion austenitic cast irons which match up well with the modern aluminium alloys, and, at the same time, offer the desired degree of wear resistance in the ring grooves. This example is typical of many similar applications in which, under modern engine conditions, aluminium and cast iron have to be mated together.

6 "Pistons with Hard Piston Ring Groove Inserts." Nickel Berie Nte. 1932. II. No. 6. June. pp. 93-95. See also Deutsche Motor Zeitschift.

Low Expansion Cast Irons

It has just been shown that the austenitic irons as normally employed are characterised by high expansion, which renders them of special service in applications in conjunction with light alloys. There are certain applications, however, where the properties of a cast iron are desired and where low expansion is required, a typical case being in press dies as used for making *papier maché* dishes. It has, for a long time, been known that in the straight nickel-iron series alloys containing about 36 per cent. of nickel

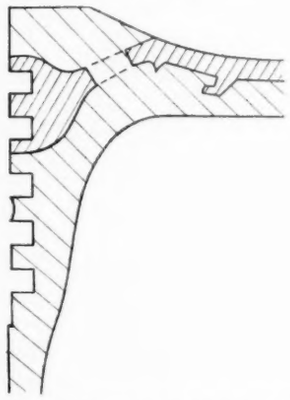

Fig. 6.—Section of Aluminium Alloy Diesel-Engine Piston with "Ni-Resist" Inserts for Piston-Ring Grooves and Flame Plate.

are characterised by a very low expansion, the expansion of this material (generally known as "Invar") being under certain conditions zero. Recent research has proved that low-expansion alloys can also be produced by the addition of a corresponding amount of nickel to cast iron, the expansion characteristics of the high-nickel irons being shown in curve Fig. 7. These high-nickel irons are, of course, irons in the austenitic series, and it is anticipated would show all the

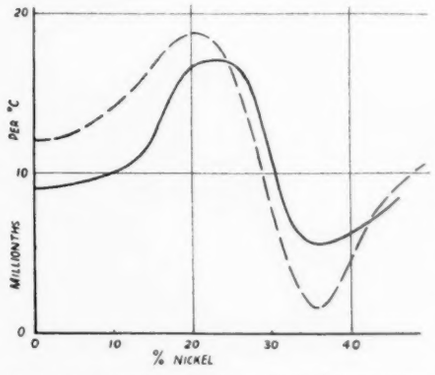

Fig. 7.—Curves showing the Coefficient of Thermal Expansion of High-Nickel Cast Irons at Normal Temperatures. Broken Curve shows Expansion of Pure Nickel-Iron Alloys for Comparison.

characteristics of these alloys, so that there are in this series, vast possibilities of obtaining combinations of heat and corrosion resistance with low expansion.

A possible application of these low-expansion alloys is in certain classes of heat-resisting castings, since, as mentioned above, a peculiarity of the normal austenitic irons is their high expansion, this high expansion frequently leading to trouble in heat-resisting castings where flame impingement or localised heating occurs. This localised heating, with its corresponding localised expansion, sometimes sets up stresses sufficiently great to destroy the casting, and it is in applications of this sort that a low-expansion heat-resisting cast iron may prove of special value and open up even wider applications for the cast-iron type of materials.

Summary

Recent developments in cast-iron practice, including the use of alloys, heat and other forms of treatment, have not only offered engineers castings with vastly improved properties, but have also led to a better understanding of the metal generally, so that it is now realised that founders are still on the threshold of its possibilities.

Strengths of 25 or even over 30 tons per sq. in. are now readily possible in commercial castings, and there is no reason why the even still higher strengths already attained in the laboratory should not be reproduced regularly on a commercial scale.

The advent of cast-iron crankshafts points to another unsuspected property of cast iron, its high fatigue resistance, now established as a result of refined laboratory tests, whilst other tests have proved the superiority of cast iron over steel in rigidity and power to damp vibration, thus again furnishing the foundryman with arguments in favour of his own material for such applications as machine-tool construction.

Alloy chilled iron castings, as for example for rolls, are now available which show service properties competing with those of the best alloy steels, whilst in the fields of heat and corrosion resistance recent work all tends to confirm the remarkable degree to which some of the previously least valued properties of cast iron may be developed.

The inherent cheapness of the cast-iron base gives even the relatively-highly alloyed materials a good start in the competition with other metals, and this advantage, coupled with the better qualities now being realised, ensures for cast iron an entry into the highest planes of engineering endeavour.

A Machine-Tool Demonstration Hall

In order to enable users in the London district to get in touch with developments in Coventry-made machine tools, Alfred Herbert, Limited, have taken premises at 70, Vauxhall Bridge Road, comprising modern well-equipped offices, a machine-tool demonstration hall, showroom, and a small tool and grinding-wheel warehouse. The machine-tool demonstration hall provides accommodation for some 60 machine tools, the majority of which will be shown at work. Line shafting, electric power and compressed air are available for demonstrating machines on actual production. This demonstration hall provides a permanent exhibition, where many of the most modern machines, equipment and methods may be inspected at any time.

View in the Demonstration Hall.

"Chromador" steel is to be used by Messrs. Dorman, Long & Company, Limited, of Middlesbrough, in the construction of the steel arch bridge across the Sabi River in South Africa.

Book Review

A.S.T.M. Proceedings, 1933. Vol. 33. Parts I and II.—Philadelphia, Pa.: American Society for Testing Materials, 260, S. Broad Street. (Price, each part, $5.50 paper, $6 cloth and $7 half leather.)

Part I contains the annual reports of 40 A.S.T.M. standing committees, and research and sectional committees. Seven extensive technical Papers are included with reports. Committee reports cover standardisation activities and also discuss the progress and results of extensive research projects sponsored by the various groups. Among subjects discussed in reports of interest to the ferrous-metals field are the following:—Steel, wrought iron, cast iron, heat-treatment, effect of temperature, corrosion, zinc coating, magnetic properties, malleable-iron castings, iron-chromium-nickel and related alloys. The report on cast iron gives the results of the extensive co-operative investigation on impact testing. This section (50 pages) contains a most comprehensive series of data on the physical properties of cast iron, and also extensive data on corrosion concerning metallic coatings and total-immersion tests.

In the part dealing with non-ferrous metals there are reports on corrosion, with extensive data from the results of atmospheric corrosion tests of metals exposed for one year; electrical-heating and electrical-resistance alloys, copper and copper alloys, and die-cast metals and alloys. Other subjects dealt with include cement, concrete and concrete aggregates, refractories, fire tests of materials, hollow masonry building units and gypsum.

Part II contains technical Papers presented at the 1933 annual meeting, with the extensive oral and written discussion. For convenience, Papers dealing with metals appear together, and the others on cement and concrete, ceramics, masonry materials and miscellaneous are also grouped. Two of the outstanding technical contributions are Papers on "Crystalline Structure in Relation to Failure of Metals—Especially by Fatigue" and the "Symposium on Cast Iron." The former was delivered by Dr. H. J. Gough (London), and is based on his extensive research work of over ten years at the National Physical Laboratory. Several Papers discuss the development and application of tests for specific properties of metals, including the torsion-impact test, modified Rohn test for creep of metals, and an "overnight" test for determining endurance limit. Papers on the fatigue properties of light metals and alloys, corrosion resistance of structural aluminium and tests of galvanised wire under pulsating tensile stress make available very valuable information and data on these subjects. Several Papers on various problems in the cement and concrete field are also included.

A number of technical contributions on miscellaneous subjects are given, including the agglutinating-value test for coal, method and apparatus for the recovery of asphalt, relative merits of film and paper for industrial X-ray work, factors in the presentation and comparison of particle-size data, and planning for the collection of standardisation data.

Projected British Foundry School

DISCUSSION IN BIRMINGHAM

The Branch-President (Mr. E. J. Lewis) said he disagreed with the suggestion that it was better for firms to train their own men. Experience was valuable, and unless a man worked in a number of foundries his experience was limited. If he remained at one establishment the tendency would be for him to follow the practice to which he had been accustomed. Employment in several foundries would counteract that tendency.

Works Training

Mr. S. H. Russell (Past-President of the Institute), referring to the same point, said there were obviously advantages and disadvantages, but personally he favoured the training of one's own staff. By so doing they were, of course, throwing bread on the waters because, if they were lucky, there was a tendency to attract rather more men than could be absorbed. The result was that some left to go to competitors and that might possibly become a source of commercial danger. With some firms the danger would be very remote, but with others, who were competing in the open market for practically the whole of their orders, the danger was more considerable. Such firms would probably hesitate to train more men than they felt they had a reasonable opportunity of absorbing into their own business. On the whole, however, he considered there were many advantages in training one's own men. It did not follow, of course, that they got them when they were sixteen. In the foundry trade it was extraordinarily difficult. The point had been frequently stressed that at the moment they were getting such a very small proportion of boys and youths who would ever make foremen. This was a serious problem and would have to be solved, of course, before the scheme outlined by Mr. Pearce could be fully developed and used. Mr. Pearce had touched on the various University courses available, and he (Mr. Russell) thought it was obvious that the proposed scheme did not clash in any way either with the ordinary B.Sc. course in Metallurgy at one of the modern universities or with the more specialised course now proposed at Sheffield University.

Cost of a Year's Maintenance

One very practical point would have to receive attention. The fees to be paid, Mr. Pearce had stated, would be £30 per annum, or otherwise for the whole course. It was almost certain that the student would have to live in Birmingham during the whole of that year. It seemed to him that before Mr. Pearce could hope to get tentative offers from students he would have to define the period of the term, while probably many would appreciate being informed as to the cost of living either in a hostel or other accommodation such as was prescribed for University students. Students wanted to know what, in addition to fees, their board was going to cost them.

Metallurgical Bias Wanted

The necessity for defining the term was that some firms sending students would require them to return to the works and to be employed during the vacations. It did not seem unreasonable to ask £500 from the industry for such a course, if there were 1,000 posts available, and there should be no difficulty in raising the money. Mr. Pearce had outlined the course and in his (Mr. Russell's) opinion had rather over-stressed the training on the practical side—the method of production, costing and so on. That was necessary, but with his (the speaker's) knowledge of what he imagined to be the suitable type of student he thought the thing to be stressed was a thorough and adequate knowledge of metals and alloys. To-day it was necessary to adhere very rigidly to certain specifications to produce certain results. The position was satisfactory in the office, where everybody knew about silicon, manganese and phosphorus and did not confuse them unduly. They could also do a certain amount of mental arithmetic and knew what percentages meant. When the matter got to the works, however, it was truly difficult to persuade an uneducated class of men to follow what was really most elementary. That was the great problem. If, as a result of the year's course, that deficiency of knowledge could be overcome, it would be very valuable. It might be necessary, if they were to get the student he imagined would be ideal for the training, to do rather more elementary mathematics and calculations than was at present contemplated. It might be found advisable for certain subjects, particularly elementary mathematics and chemistry, to subdivide the class so that the instruction should not be over the heads of certain students or, on the other hand, brought down to the level of the uneducated student. Mr. Russell added that they were all greatly indebted to Mr. Pearce for his Paper. Mr. Pearce, he said, had been one of the most stimulating persons on education in the industry, and the industry needed a lot of stimulation. He proposed a hearty vote of thanks to Mr. Pearce for his Paper.

Inadequacy of Evening Classes

Dr. D. S. Anderson (Principal, Birmingham Central Training College), in seconding the proposition, described the Paper as original and most interesting. The scheme, as Mr. Pearce had indicated, was unique in the educational system of this country. It filled a gap, and if the school was established he had no doubt as to its success. Other industries would probably follow suit. As Mr. Pearce had mentioned, a somewhat similar arrangement existed in France, where it was not confined to the foundry industry. There was a special High School of Textiles at Turcoing and a special School of Ceramics at Sevres, and one or two others, where people from industry and the university received a year's intensive training and then took up posts in industry. He did not think there was any doubt that the present part-time system of education in evening classes, which was the only system available at present, did not fill the whole bill. It was quite all right up to a point for young employees who were taking it concurrently with their apprenticeship. But there must be many cases where older men felt the need of training, or where a firm wished to train a man for a particular post. The fact that the Board of Education was supporting the scheme was, in itself, proof that it was a thoroughly sound scheme. The Board of Education was an extremely cautious body and one of the most difficult things in the world was to wring any money out of it. If Mr. Pearce had been able to get a promise of such support he thought his achievement ranked little short of a miracle.

The City and Guilds Effort

He (Dr. Anderson) was not in the founding industry, but he supposed there must be an acute dearth of really well-trained people, because he knew that all over the country the attendance at the present evening courses in foundry work and patternmaking was most disappointing. Speaking from memory, the total number of students who entered for the City and Guilds examinations was about thirty or forty. There could not be nearly sufficient well-trained people to staff the foundries of the country, and while he hoped the number would grow under the new scheme that had recently been set up, there must be many jobs for which that type of training was not adequate. Mr. Russell had suggested that there might be some difficulty in running this group of students as a single class. Probably there might be, but the fact that it was proposed to locate the school in a Technical College provided facilities whereby the difficulties of difference in standard might be overcome. He sincerely hoped that the scheme would go through. He was convinced it would be a complete success, and an example which other trades would not be slow to follow. Mr. Pearce was to be congratulated on bringing the scheme forward.

The vote of thanks to Mr. Pearce was heartily accorded.

The Sheffield University Degree Course

Prof. J. H. Andrew (University of Sheffield) said they would all welcome the scheme detailed by Mr. Pearce. Naturally, being educationists, they were prepared to support any proposals for the better education of industry in general. Mr. Pearce had said that his scheme and the Sheffield scheme did not clash in any way whatsoever, and he (Dr. Andrew) agreed. The Sheffield scheme would provide four years' training in science and practice for the matriculated youth. Mr. Pearce's scheme aimed at training those who had shown themselves competent in the practical work of the foundry, and covered an entirely different class from the Sheffield scheme. He hoped the new project would receive the support of the foundry industry. He was convinced that if the scheme went forward, and was a success, as it would be with Mr. Pearce at the head, the industry would develop and reap considerable benefit. Mr. Pearce had not given them a very detailed account of the courses proposed, and it was perhaps too early for anyone like himself (Dr. Andrew) to make any criticism. He agreed, however, with what Mr. Russell had said, and he hoped that Mr. Pearce would rather concentrate on the metallurgical and the refractories and sand side. The engineering side had recently been greatly developed in the foundry and was often thoroughly up to date. The weakness lay, largely, in the metallurgical operations and in the understanding of metallurgical facts and processes.

The Foreign Student

Mr. Pearce had alluded to attracting foreigners, and with regard to that matter he (Prof. Andrew) would like to issue a word of warning. The question had arisen in the universities, and there were two viewpoints. One was that foreigners came here to the university or technical school with the idea of learning what they could and on returning bought from us. The other was that foreigners—and he rather feared the majority—came here with the idea of learning our operations and all about the work we were doing with the idea of taking home the details and immediately manufacturing in their own country. He would express his view in this way, that it might not be advisable to entice the foreigner to a large extent. Prof. Andrew repeated that he welcomed the scheme and hoped the industry would give it ardent support. He wished Mr. Pearce every success, and given enthusiasm and encouragement, upon which everything depended, he was confident that Mr. Pearce would get the scheme through. In selecting his staff, he hoped that Mr. Pearce would choose lecturers and demonstrators who could encourage and enthuse the students.

Planning and Costing—The Essential

Mr. A. J. Shore said that any scheme which aimed at raising the status of the foundry trade as a whole should claim their active support. From the point of view of £ s. d. they all stood to benefit. He rather disagreed with Prof. Andrew and Mr. Russell in stressing the metallurgical side, because he felt that was already well cared for by the technical societies, the British Cast Iron Research Association and the wealth of literature available. In his opinion

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it was the costing and foundry-planning side that needed attention.

The Sandwich System

Mr. F. J. Cook (Past-President of the Institute) said it had been recognised by the Institute almost from its inception that there was great need for further developments on the educational side, and as far back as 1912 a committee was formed with the aim of assisting technical schools by supplying them with a suitable curriculum. A three-years' course was planned, but the war intervened and nothing came of the scheme. He agreed with Prof. Andrew that the new project did not clash in any way with the Sheffield proposal. The discussion raised the old contentious point as to whether a sandwich system was better, or whether a man should take his education before he came into the foundry. From the practical point of view he did not think there could be any doubt as to the value of a sandwich system such as was suggested. The practical man realised his lack of education. He often experienced difficulties and recognised his inability to deal with them. He (Mr. Cook) therefore thought there was everything to be said in favour of a scheme such as Mr. Pearce had outlined. As a foundry manager, what he found lacking was men who, when a difficulty arose, could pronounce what was the cause of the trouble. They proceeded by trial and error, without any scientific guidance as to the cause of the trouble and the means of curing it. The scheme proposed would provide men who could hold an inquest on a failure and come to a reasonable decision as to what was responsible. In his opinion, the metallurgical side required a great deal of emphasis if the best results were to be obtained. At the same time, there was an appalling lack of knowledge of costing—which he was pleased to know would not be overlooked in the curriculum—and the question of planning was also very important.

Selection of Students

Mr. E. W. Wynn thought the selection of the right type of student was going to be difficult. He also laid stress on the necessity of educating the employer as well as the foundryman. If there was more appreciation and encouragement on the part of the management, he believed there would be an adequate supply of the kind of men wanted.

Mr. G. R. Shotton referred to the difficulty of running a single class for a year in which there were students from all branches of the industry, and suggested, as an alternative, that the class should be run for the first term only as a general class, covering all fields. In the second and third terms it might be advisable to split the class into ferrous and non-ferrous, and allow the students to follow their own particular line of investigations.

Entrance Examinations

Mr. D. H. Wood said he had no doubt that Mr. Pearce's scheme would be welcomed by the whole industry. He understood Mr. Pearce to say that prospective students would be expected to have reached a certain standard of education. He imagined that the entrance examination would be rather difficult to formulate, particularly if the class comprised both ferrous and non-ferrous metals. Further, if the course was to include, in addition, costing and other subjects, it would not be easy to discover students possessing a knowledge of the subjects sufficient to pass the examination. One reason why he thought the scheme or a similar scheme, was essential was the decreasing number of skilled men in the industry. Other methods of production—by means of semi-skilled and unskilled labour—were absolutely vital if the industry was to continue and the use of castings was to grow. He earnestly hoped that the industry would support the scheme and that it would be possible to start the first course in October next.

AUTHOR'S REPLY

Mr. J. G. Pearce, discussing a number of the points raised, said that if the President and himself differed on the question as to whether or not a firm should train its own men, it was possibly because they meant slightly different things by training and experience. When he spoke about training, he meant something specific and definite, and not merely the acquisition of experience by doing the day's particular tasks. His experience in industry was that it paid firms to train their own men, and that if they took special steps to offer them any sort of systematic training they did not want to lose them, and that, on the whole, it was better to do that than to get men from outside. He was particularly grateful to Prof. Andrew for his remarks, because he wanted to make it clear that there was no overlapping in the two schemes. There was no reservation in their minds when they said that each supported the other and that they hoped to do all they legitimately could to assist both. In reply to Mr. Russell, he thought it would be quite easy to specify the length of the terms, as well as the cost of living in the city for the period covered. The question of the curriculum, he thought, might well be left to the governing body. Views had been expressed on both sides. Some thought the metallurgical side should be stressed; others were of opinion that the emphasis should be on organisation and costing. He had not the slightest doubt that the matter could be adjusted satisfactorily. As to the standard required for admission, there was no doubt that if they laid down a definite standard, such as the possession of a special certificate, they would find the students varying very widely among themselves. But with a small class, he thought, the difficulties could be overcome.

On this and other matters, however, he asked them to bear in mind that the scheme would be governed by the industry. He thought the interests of the industry would be safe in the hands of the industry. He was glad to have Mr. Shore's stress on the importance of costing and planning. Personally, he was always inclined to regard production costings as an engineering job. Consequently he thought they should regard the scheme primarily from the point of view of producing. That tended to make the metallurgical aspect, he would not say subsidiary, but to put it into proper perspective with the engineering questions of output, time of delivery, and so forth. They did not want to so bias the course that they were turning out men who knew how to make castings, but did not know how to make them cheaply and deliver them quickly. As to Mr. Hall's remarks, he (Mr. Pearce) was submitting a scheme which was capable of being run at the comparatively insignificant cost of £500 a year. But he was not a miracle worker. He could not endow the scheme to such an extent that funds could be provided to release any and every man who would like to attend. That was a problem which the individual must solve, though it was possible that the industry could help. For example, if they could raise more than £500, for every £150 a year they could raise in excess of that amount, an additional man could be endowed. They might possibly, also, offer a scholarship for the best man at the entrance examination, if they had one. Mr. Shotton had raised a very interesting point as to the possibility of splitting up the class into ferrous and non-ferrous sections in the second and third terms. His own (Mr. Pearce's) view was that in the founding processes there was an essential unity of operation, of technique, and that to some extent it could be taught regardless of the actual metal which happened to be involved. He thought that grey-iron founders would learn a great deal if they were able to work for six months in a steel foundry, and that both would profit by experience in a non-ferrous foundry. One of the remarkable things that was happening in research work at the present time was the extent to which development in one field was fertilising other fields—the question of gases in metals was an example. He would have to be convinced that specialisation was desirable before assenting to the course being chopped up into sections. He agreed with Mr. Wood that an entrance examination presented difficulties. It might be possible to arrange entry on a man's record. Mr. Wood had referred to the decreasing number of skilled men in the industry, and he (Mr. Pearce) had heard from a member that night of the enormous difficulty of getting skilled men at the present time. They all knew how rapidly the face of the industry was changing owing to mechanised production methods. All that was going to call not for less provision at the top, but more. It was going to increase the demand for men at the top who could control labour and do the thinking, and embody the thinking in apparatus and equipment. So far as labour itself was concerned, he thought they wanted less and less special manual skill and more and more adaptability of mind, which would enable a man, if necessary, to go to a new job and make as good a success of it as the old one. Mr. Pearce added that he inferred from the discussion that the scheme commended itself to those present. What he proposed to do was to bring it to the notice of the Council of the Institute, with a view to securing their formal support. If they got that, they could go straight ahead.

East Midlands Foundrymen Elect New Officers

The East Midlands Branch of the Institute of British Foundrymen held its annual meeting at Loughborough College on March 24, 1934. Mr. P. A. Russell presided. The Secretary (Mr. H. Bunting), in his report of the session's work, said there had been seven meetings and one works visit, with an average attendance of 47. The membership was slightly lower at 110, but this figure could be considered satisfactory in view of the bad trade conditions which had been prevalent, and of the fact that some names had been deleted. The present list could be considered as a live membership. The Branch library continued to be a very useful part of the Branch activities, books being out during the year for 1,104 days.

The President had much regret in stating that Mr. Bunting wished to retire from the office of Branch-Secretary. Everyone knew of the service given by Mr. Bunting during the past 19 years, but owing to increasing business activities, he now felt the position becoming onerous. On the President's suggestion, Mr. Bunting was induced to remain Secretary for a further year with the help of an assistant secretary, who would then be better fitted to carry on the work Mr. Bunting was vacating.

The election of officers for the session 1934-35 was as follows:—*President*, Mr. A. E. Peace; *Senior Vice-President*, Mr. J. F. Driver; *Junior Vice-President*, Mr. H. Bunting; *Secretary*, Mr. H. Bunting; *Assistant Secretary*, Mr. B. Gale; *Auditors*, Mr. H. J. Hilton and Mr. W. F. Smith; *Delegates to General Council*, Messrs. P. A. Russell, T. Spiers and C. Bigg; *Branch Council*, Messrs. H. J. Beck, R. Orme, H. Vaughan and F. Gill.

A vote of thanks was accorded to the officers for the past session on the motion of Mr. Hillman.

Following the general meeting, the President said he was sorry the Short-Paper Competition had met with poor response, only one Paper being entered. Under these circumstances there could be no competition. The prize would be awarded to the only entrant and the author would be asked to read his own Paper, which would then be open for discussion. A Paper entitled "Continuous Casting" was then read by Mr. Frank Butters.

This Week's News in Brief

Trade Talk

THE NEW PADDLE STEAMER "Caledonia," built by Messrs. Denny Bros. & Company, Limited, Dumbarton, for the L.M.S. Clyde service, has completed very successful trials on the Clyde.

IN THE FACE of intense competition from Europe and America, the North British Locomotive Company, of Glasgow, has obtained from the South African Railways a contract for 50 locomotives, costing £300,000.

AN INCREASE OF ACTIVITIES in Clydebank is indicated by the larger donations to charity from the employees of Singer's works at Kilbowie for the first quarter of 1934. The amount disbursed is £580 19s. 3d., which is about £80 more than in the corresponding quarter of 1933.

A FIRE CAUSED BY CHILDREN playing in a grass park adjoining the foundry of the Burnbank Iron Company, Limited, Falkirk, endangered the moulding and pattern shops situated on the banks of the Forth and Clyde Canal, and it was only by desperate efforts of the fire brigade that a large amount of damage was prevented.

THE TORPEDO DESTROYER "Escort," which has been built for the Admiralty under the 1931 programme, has been launched from Messrs. Scott's Shipbuilding & Engineering Company's yard at Greenock. The "Escort" is a sister ship to the "Escapade," launched by Messrs. Scotts in January.

UNIFORMS WORN by the new volunteer force at present being formed in the Irish Free State are being fitted with chromium-plated buttons, badges and belt fittings. These accessories, which are something of an innovation in the matter of soldiers' equipment, are being turned out by the Irish Metal & Chromium Plating Company, Limited, Westmoreland Row, Dublin.

A CONSIDERABLE AMOUNT OF WORK will be created for various classes of artisans by a record order which Messrs. Bruce Peebles & Company, Limited, Edinburgh, have received for 23 units of electrical rectifying plant, of a total capacity of over 75,000 h.p., for the Southern Railway. The firm have already supplied 18 units of 3,000 h.p. each to the same railway company, and the present order is the largest ever placed in this country.

FIRE BROKE OUT in the works of Messrs. Alexander Marshall (Glasgow), Limited, in Geendyke Street, Glasgow, last week. The firemen, although hindered by dense smoke, succeeded in getting the outbreak under control after two hours' strenuous work. Machinery and the contents of three floors were damaged, but the work of the firm will not be interfered with to any extent as a result of the fire.

THE NATIONAL SLUM-CLEARANCE PROGRAMME has created a sustained demand for the products of Falkirk's many foundries. Leaders of the industry are predicting the advent of another prosperity period. Additional briskness should permit of workers at the moment on short time being able to secure a full week's work. The expected boom in private building enterprise, should it materialise, would give Falkirk excellent prospects.

A DEFECTIVE FLUE of an annealing furnace caused the ignition of the roof of the Clyde Boiler and Engineering Works of Messrs. John Marshall & Company (Motherwell), Limited, in Park Street, Motherwell. The fire brigade succeeded in confining the fire to the one building, and the damage, estimated at a few hundred pounds, was limited to the walls, roof and hydraulic plant. The work of the firm will not be interrupted.

PRELIMINARY OPERATIONS for the erection of a metal foundry and steel workshop have begun on a 12-acre site at Emek Zebulun, Haifa Bay, Palestine. A Jewish immigrant, Mr. J. Karminer, will transfer his factory there from abroad. Thirty thousand pounds are to be invested in the new enterprise. The raw material will be imported, smelted at the factory, and turned into metal for articles of all kinds, including pipes and steel frames. The first factory in Palestine for the manufacture of locks will also begin operations soon. It is to be known as the Haifa Lock Works, and is being erected on the new industrial zone at Haifa Bay. Mr. G. Schwartz and two engineers from Germany and Switzerland are the owners. The factory, which will also produce other iron articles, will be equipped with modern machinery.

TOO LARGE TO TRAVEL by rail, a steel casting, weighing close upon 40 tons, was despatched to Sheffield by road on Monday from the foundry of Messrs. Noble & Lund, Limited, machine-tool makers, of Felling-on-Tyne. It is to form part of the biggest lathe the firm has constructed during the past 50 years, and is to the order of the English Steel Corporation, Limited. Driven by a 250-h.p. electric motor, the lathe will admit forgings up to 60 ft. in length by 80 in. in diameter and weighing 250 tons. There are 62 push buttons for the control of the various movements. Messrs. Noble & Lund regard it as the most powerful lathe yet constructed.

THE INCREASING DEMAND for the specialised types of the conveying and mechanical loading machinery produced at the East Kilbride Works of Mavor & Coulson, Limited, has necessitated considerable extension of accommodation. Contracts have been arranged and work is now in progress on two considerable additions to the existing buildings; one of these increases the assembling space for joy loaders, which in underground service have clearly established their place, and for use on the surface are also fulfilling requirements not hitherto served. The other addition is that of a large warehouse for raw materials and finished products, to release existing space for production of conveyors. Both additions are equipped with overhead travelling cranes and the extensions provide about 20,000 sq. ft. additional floor space, this being a further stage in the fulfilment of the original plan of the works.

Obituary

MR. SIMPSON ELLIOTT, who had for many years been in the employ of Messrs. Mirrlees Watson & Company, Limited, Glasgow, died at his home in Glasgow on March 29.

MR. HENRY JOHN CHAPPELL, of Messrs. Bailey, Pegg & Company, Limited, Brierley Foundry, Brierley Hill, Staffs, died on Saturday, March 24, at the age of 70 years.

THE DEATH OCCURRED, at his residence, Nithsdale Road, Pollokshields, Glasgow, on March 24, of Mr. Archibald Samuel Potter, of Messrs. Robert Potter & Sons, Limited, Govan Foundry, Glasgow.

WE REGRET TO REPORT the death, in Paris, at the age of 92, of Mr. Alexandre Pourcel, the oldest member of the Association Technique de Fonderie. Mr. Pourcel, whose promotion to the grade of officer of the Legion of Honour was announced at the end of last year, was a mining engineer, an honorary member of the *Comité des Forges de France* and of the American Institute of Mining and Metallurgy, and an honorary Vice-President of the Iron and Steel Institute. He was awarded the Bessemer Medal in 1909.

New Companies

British Metal Powders, Limited, 8, Botolph Lane, London, E.C.4.—Capital, £5,000. Directors: E. J. Bisiker and E. Bisiker.

Zirker & Sambidge, Limited, 17, Victoria Street, London, S.W.1.—Capital, £500. Exporters of mechanical and electrical machinery. Directors: J. Sambidge, J. S. Sambidge and Dr. G. H. Zirker.

Patent Axle-Box & Foundry Company (1934), Limited.—Capital, £10,000. Directors: W. A. Dawkins; J. E. Mardon, Southfield, Watford Road, Northwood, Middlesex; B. J. Dawkins and E. M. Slatter.

Credit for Industry, Limited.—Capital, £250,000. To lend or advance money for the purposes of establishing, carrying on or extending trade or industry; and to carry on the business of banking, discounting, etc. Subscriber: R. Collins, 1, Threadneedle Street, London, E.C.2.

Silal and Nicrosilal

Mr. R. C. H. Weeks has written to point out that in his Paper on "Modern Ironfoundry Practice," published in THE FOUNDRY TRADE JOURNAL of March 8, 1934, he omitted to mention that Silal and Nicrosilal are covered by Patents granted to the British Cast Iron Research Association.

Personal

CAPT. R. F. HILTON, managing director of the United Steel Companies, Limited, has joined the boards of the British Power & Light Corporation (1929), Limited, and the North Wales Power Company, Limited.

MR. EMILE MOND has been appointed chairman of Messrs. Ashmore, Benson, Pease & Company, Limited, of Stockton-on-Tees, in place of the late Mr. E. Lloyd Pease. MR. WILFRED BESWICK (managing director) has been elected vice-chairman in place of Mr. Emile Mond. Mr. Mond also becomes chairman of the Power-Gas Corporation, Limited, of which SIR CHRISTOPHER CLAYTON, M.P., has been elected vice-chairman.

MR. J. T. HENRY AND MR. J. W. WALKER have been appointed joint general managers of what is known as the "Templeborough Division" of Sheffield Steel Products, Limited. The "Templeborough Division" includes the Templeborough branch of the concern, Messrs. George Plumpton & Company, Warrington, the Hirst Hollow Colliery, Bradway, and the Mowbray Street concerns of W. K. & C. Peace, Limited, Moses Eadon & Son, Limited, etc. Mr. Henry has served the firm for many years as sales manager of different sections, and has, for the last few years, been commercial and sales manager at Templeborough Works. Mr. Walker has for many years been works manager at Templeborough, and more recently has also controlled the works at Mowbray Street.

Company Reports

Bruce, Peebles & Company, Limited.—Trading loss for 1933, £10,951; brought in, £436; from general reserve, £11,000; carried forward, £483.

Parkinson & Cowan, Limited.—Dividend at the rate of 7 per cent. per annum on the preference shares for the half-year ended September 30, 1933.

Thos. W. Ward, Limited.—The directors announce that one year's dividend is to be paid on the 5 per cent. first cumulative preference shares to June 30, 1932.

Edgar Allen & Company, Limited.—Payment of the dividend on the 5 per cent. cumulative preference shares for the half-year ending March 31 will be deferred.

Stewarts and Lloyds, Limited.—The directors recommend the following dividends for the year to December 31 last: Six per cent. per annum on first preference shares, 10 per cent. per annum on the second preference shares, 5 per cent. per annum on the third preference shares, 6d. per share on the deferred shares, and on the liaison deferred shares at the same rate relatively as the deferred shares.

Lancashire Steel Corporation, Limited.—Earnings, including those of the wholly-owned subsidiaries, £156,756; net profit, including income from advances, trade investments, etc., and after providing £71,555 for interest on amounts provided by the guarantee group and on the deferred liability for the construction of the Canal Wharf, £96,179 (subject to depreciation); brought in, £52,705; to central reserve for depreciation of fixed assets, £50,000; to general reserve, £40,000; carried forward, £58,884.

Contracts Open

Dewsbury, April 9.—Railway weighbridge, suitable for weighing 20-ton automatic-discharge coal wagons, for the Town Council. The Engineer and Manager, Gasworks, Savile Town, Dewsbury.

Johannesburg, April 21.—500 special meter boxes of malleable cast iron or cast steel, for the Johannesburg City Council. The Department of Overseas Trade. (Reference G.Y. 13,633.)

Richmond, April 16.—Supply and laying of 11 miles of 7-in., 6-in., 5-in., 4-in. and 3-in. spun cast-iron water mains, with fittings, etc. Messrs. Taylor & Wallin, 1, Saville Place, Newcastle-upon-Tyne. (Fee £10, returnable.)

Czecho-Slovak Steelworks Report

The annual report for 1933 of the Poldi-Hütte, Prague, one of the principal Czecho-Slovak iron and steel concerns, shows a profit of 7,518,700 Cz. crowns, as against 6,723,000 cr. in the previous year. Administration charges in 1933 (1932) were 2,600 (2,705) million cr., taxes and levies 1,317 (1,627) million cr., and interest charges 2,070 (2,207) million cr. Business in the current year is reported to show a marked improvement.

XUM

Raw Material Markets

There are no developments of importance to report in the iron and steel markets, holiday conditions having prevailed during the past week. New business has been limited, but the pig-iron producers have ample work on hand, and the prospects for the new quarter are decidedly good. A state of tension exists in the base-metal market, following on the sudden upward movement in tin and the placing of restrictions on copper imports on the Continent.

Pig-Iron

MIDDLESBROUGH.—The producers of Cleveland foundry iron are heavily booked for some months ahead, and could thus view with equanimity any accumulations of stocks that occurred over the holiday period. The output of iron is now at its highest level since 1930, but is nevertheless being fully absorbed by the current demand. Prices remain at the fixed minimum level. For No. 3 Cleveland G.M.B. foundry iron 67s. 3d. per ton delivered Falkirk is the lowest price quoted. Middlesbrough and district consumers pay 67s. 6d., North-East Coast buyers 69s. 6d. and Glasgow 70s. 3d. No. 1 foundry quality is 2s. 6d. per ton more than No. 3 G.M.B., and 1s. less than No. 3 is charged for No. 4 foundry and No. 4 forge iron.

Export orders for East Coast hematite are few and far between, but there continues to be a heavy home demand, largely from Sheffield, the Midlands and South Wales. The new fixed prices are being firmly adhered to. These prices are based on East Coast hematite, No. 1 grade, at 68s. per ton delivered in the Middlesbrough area, 70s. per ton delivered other North-East Coast destinations, 75s. delivered Scotland, 76s. delivered Lancashire and 79s. delivered Midlands.

LANCASHIRE.—Good deliveries of iron are being made to foundries in this area, and a further expansion is hoped for this quarter. For delivery in the Widnes area, Derbyshire, Staffordshire and North-East Coast brands of No. 3 foundry iron are quoted on the basis of 72s. 6d. per ton, but in all other parts of Lancashire the basis price is 74s., with Northants at 72s. 6d. and Derbyshire forge at 69s. to approved consumers and a minimum of 70s. to foundries. The demand for Scottish iron by Lancashire foundries continues on a low scale, owing to the keen competition from Indian iron, with offers in the region of 83s. per ton, delivered.

MIDLANDS.—Conditions are rather quiet at the moment, but a certain amount of forward buying should develop this month, as the majority of consumers are not covered beyond the end of June. In the meantime, the biggest tonnage is going into the light-castings trade, with an improved demand from the general-engineering section. The minimum rates applying to Birmingham and Black Country stations are 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Staffs and Lincolnshire No. 3, with 4s. to 5s. less for forge iron. There is a little more business about for the better grades of iron for the engineering works. Scottish No. 3 is offered at between 87s. 6d. and 90s.; low-phosphorus iron from 82s. 6d. to 90s., and minimum-phosphorus grades from 75s. to 80s., with quotations varying from £6 15s. to £7 15s. per ton for special refined iron.

SCOTLAND.—Although the Easter holidays did not apply to the works here, the market has nevertheless been quiet. The official price for Scottish iron remains at 70s. per ton for No. 3 foundry f.o.t. furnaces, with 2s. 6d. extra for No. 1. No. 3 Cleveland is quoted at 67s. 3d. at Falkirk and 70s. 3d. at Glasgow, with other English irons 1s. 3d. per ton below these figures. It is reported that another furnace is to be blown in shortly on hematite. The total number of stacks in operation will then be fifteen.

Coke

Producers of foundry coke have been showing more willingness to book ahead, but even so have chosen not to go beyond June at the present rates, which, for delivery in the South Staffordshire area, are as follow:—Best Durham coke, 36s. 6d. to 40s.; Welsh coke, 36s. to 45s. per ton.

Steel

In spite of holiday influences, business in semi-finished steel has continued on steady lines. Competitive offers of material have lately been made by the Continental manufacturers, but little business has resulted. The chief feature of the finished-steel market continues to be the demand for bars and strip. The call for heavy products is also gradually improving, but is still limited.

Scrap

There has lately been a dull tone in the Cleveland scrap-iron market, buyers not being prepared to pay more than 50s. for ordinary heavy cast iron and 53s. for machinery metal broken to convenient sizes. There continues to be a good demand for scrap iron in the Midlands, where heavy machinery metal is offered at 55s. delivered, good heavy pipe and plate at 50s. and clean light scrap at 47s. 6d., all delivered works. In South Wales, good cast-iron machinery scrap in furnace sizes is slightly more active at about 47s. 6d. to 50s. The situation in the Scottish scrap-iron market remains fairly steady, there being little change in prices.

Metals

Copper.—The tone of the market has remained fairly firm, but there has been little business with consumers, owing to the holidays. Now that these are over, it is expected that a fairly considerable buying movement will develop shortly.

The news that the proposed code for the conduct of the copper industry in the United States had at last been agreed upon came through before the holiday. Details of the agreement are not yet known but, if, as has been stated, the Code contains provisions for shorter working hours and an increase in wages, a rise in the American domestic price of copper may be looked for.

The week's prices have been as follow:—

Cash.—Wednesday, £32 to £32 1s. 3d.; Thursday, £32 5s. to £32 6s. 3d.; Tuesday, £32 7s. 6d. to £32 8s. 9d.; Wednesday, £32 3s. 9d. to £32 5s.

Three Months.—Wednesday, £32 6s. 3d. to £32 7s. 6d.; Thursday, £32 11s. 3d. to £32 12s. 6d.; Tuesday, £32 12s. 6d. to £32 13s. 9d.; Wednesday, £32 10s. to £32 11s. 3d.

Tin.—The tin market maintains its firm tone, there being little change in actual conditions to report. The demand from consumers in this country and on the Continent is well maintained, but the American market has lately developed hesitancy. There is a strong possibility of a shortage of supplies developing later on this month, as, although this is the season when consumption normally expands, the producers have decided that output shall remain at the low level of recent months.

Daily quotations:—

Cash.—Wednesday, £237 10s. to £237 15s.; Thursday, £238 12s. 6d. to £238 15s.; Tuesday, £237 5s. to £237 10s.; Wednesday, £235 5s. to £235 10s.

Three Months.—Wednesday, £236 2s. 6d. to £236 5s.; Thursday, £237 to £237 2s. 6d.; Tuesday, £236 12s. 6d. to £236 15s.; Wednesday, £235 to £235 2s. 6d.

Spelter.—There has been a noticeable lack of fluctuation in spelter prices lately. Consumption is fairly good in this country, always excluding, of course, the galvanising trade, which remains depressed. Improving conditions are reported from the Continent.

Price fluctuations:—

Ordinary.—Wednesday, £14 17s. 6d.; Thursday, £15 2s. 6d.; Tuesday, £14 17s. 6d.; Wednesday, £14 13s. 9d

Lead.—The trade demand for lead has been limited. There has been no inclination to press sales, however, so that prices have been fully maintained.

Daily market prices:—

Soft Foreign (Prompt).—Wednesday, £11 12s. 6d.; Thursday, £11 12s. 6d.; Tuesday, £11 10s.; Wednesday, £11 5s.

Correspondence

(*Concluded from page* 222)

on the following morning, the young men will travel to Bruges, spending the night there and departing on April 14 for London.

As the cost per head to the students participating is only £6 10s., it is not surprising that so many young metallurgists, at the beginning of their professional careers, have taken advantage of the tour that the Institute of Metals—with the co-operation of the National Union of Students—has arranged. The large participation in the tour has been most encouraging to the Council, and it is expected that visits to other industrial centres on the Continent will be arranged at a later date. Students desirous of participating in future tours should communicate with the writer.—Yours, etc.,

G. Shaw Scott.

Institute of Metals,
36, Victoria Street, S.W.1.

Coal Dust

To the Editor of The Foundry Trade Journal.

Sir,—Mr. B. Hird, in his kindly criticism of the coal-dust section of my Paper on "Light Castings for Enamelling," appears to contradict himself by agreeing that "Coal dust . . . tends to decrease the strength of the sand" and stating that "a bond can be obtained from raw coal dust due to the fineness of the material."

As regards the Papers to which he refers me, I am cognisant of the excellent work of both Mr. Hudson and himself, but would like to remind him that I dealt with a particular branch of light casting, *i.e.*, that for enamelling work, and in the absence of proof to the contrary, am content to rest by my own convictions.

His concluding statement that "Coal dust creates a gas which forms a refractory film between the molten metal and the face of the mould, etc.," revives an old controversy. If the permeability of the sand is of such importance then it is difficult to believe in the existence and effect of such a refractory film.—Yours, etc.,

H. B. McNair.

14, Seabeg Crescent,
Bonnybridge, Stirlingshire.
March 26, 1934.

Catalogue Received

Forgings. Messrs. Thos. Firth & John Brown, Limited, of Sheffield, have sent us a particularly handsome brochure, which very thoroughly covers the whole field of steel forgings. The illustrations, especially the coloured detachable picture of a 6,000-ton press, are excellent, whilst the letterpress is intelligently composed and well set out. There is a wealth of technical information, both in the text and the extensive tables. Readers who are sufficiently fortunate to receive a copy of the book, will envy the high perfection the science and art of forging has reached in this world-renowned concern.

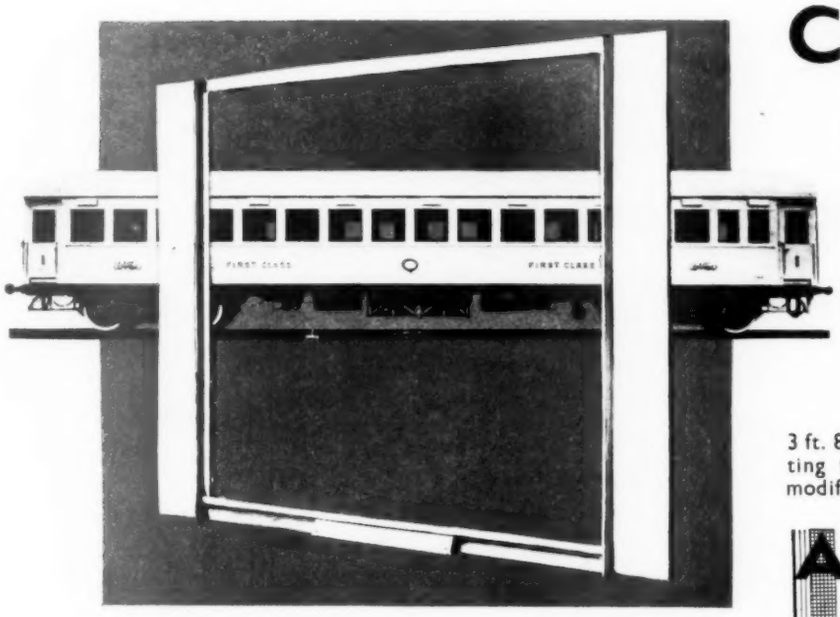
The Use of Sodium Carbonate in Iron and Steel Works

(*Concluded from page* 226)

fore, to add a flux which will combine with, or dissolve the small oxide particles, and by increasing their size, carry them up to the surface. Sodium carbonate appears to be one of the most useful substances for this purpose, as it melts readily (at 851 deg. C.), forms a fluid slag, and is not unduly volatile at the melting temperature of brass and bronze.

It will be seen that the principle underlying this is the same as that whereby oxides, silicates and sulphides are removed from cast iron.

The author wishes to express his thanks to the directors of Imperial Chemical Industries, Limited, for permission to publish this Paper.



CASTINGS $\frac{1}{8}$" *thick*

The illustration shows a body sidelight frame die-cast in "Alpax" (aluminium alloy) as supplied by Messrs. Lightalloys Ltd. to the Leeds Forge Co. for some first-class coaches of the Egyptian State Railway. The frames shown form the complete exterior of the coach from the waistline to the underneath of the ventilators. The weight of one complete casting is 7 lb. 8 oz.; its size 3 ft. 8 in. by 3 ft.; its thickness $\frac{1}{8}$ in., demonstrating the thin sectioning which is possible with modified aluminium-silicon alloy.

BA ALUMINIUM AND LIGHT ALLOYS
The BRITISH ALUMINIUM CO. *Ltd.*
HEAD OFFICE: ADELAIDE HOUSE, KING WILLIAM ST., LONDON, E.C.4.
TELEPHONE: MANSION HOUSE 5561 & 8074 (5 LINES) TELEGRAMS: CRYOLITE, BILGATE, LONDON

The BRITISH ALUMINIUM COMPANY *Ltd.*

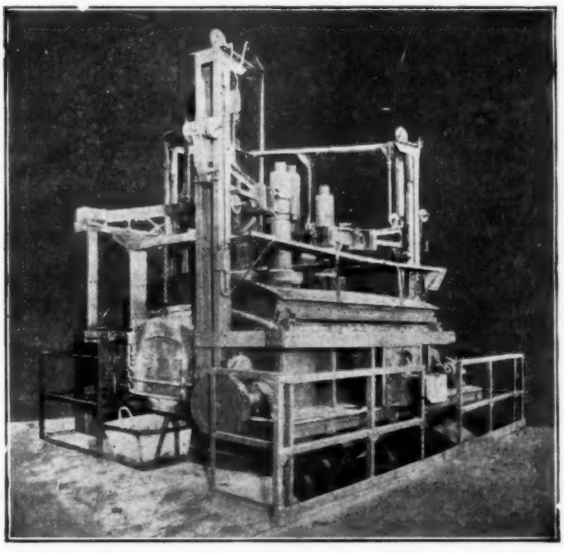
F.T.J.5.4.34.

GREAVES-ETCHELLS ELECTRIC STEEL FURNACES

MORE THAN 100 FURNACES SUPPLIED DURING LAST 7 YEARS.

WATSON ROTATING ELECTRIC FURNACES Ensure RAPID & CLEAN MELTING

THOROUGH MIXING.



NON-FERROUS METAL MELTING ELECTRIC FURNACES

SINGLE, TWO, or THREE PHASE.

CONTRACTORS TO HOME AND FOREIGN GOVERNMENTS.

WATSONS (METALLURGISTS) LIMITED

Adelaide Works, Mowbray Street, SHEFFIELD, 3.

RAW MATERIALS—PRICE LIST

(Wednesday, April 4, 1934)

COPPER

	£	s.	d.
Standard cash	32	3	9
Three months	32	10	0
Electrolytic	35	10	0
Tough	34	10	0
Best selected	35	0	0
Sheets	62	0	0
India	44	0	0
Wire bars	35	15	0
Ingot bars	35	15	0
H.C. wire rods	38	0	0
Off. av. cash, March	32	10	8 3/16
Do., 3 mths., March	32	15	1 1/16
Do., Sttlmnt., March	32	10	7 1/16
Do., Electro, March	35	15	1 3/16
Do., B.S., March	35	10	10
Do., wire bars, March	36	0	0
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	235	5	0
Three months	235	0	0
English	236	0	0
Bars	237	10	0
Straits	238	0	0
Australian	237	5	0
Eastern	239	0	0
Banca (nom.)	238	15	0
Off. av. cash, March	233	19	2
Do., 3 mths., March	232	11	8
Do., Sttlmt., March	233	18	9 3/7

SPELTER

	£	s.	d.
Ordinary	14	13	9
Remelted	15	5	0
Hard	12	10	0
Electro 99.9	17	5	0
English	15	12	6
India	14	12	6
Zinc dust	20	0	0
Zinc ashes	3	5	0
Off. aver., March	14	17	8½
Aver. spot, March	15	0	7 3/7

LEAD

	£	s.	d.
Soft foreign ppt.	11	5	0
Empire	11	10	0
English	12	15	0
Off. average, March	11	13	10 3/7
Average spot, March	11	10	10 5/7

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex whse.	23	0	0
Rods	29	0	0

ANTIMONY

	£	s.	d.
English	39 0 0 to 40	0	0
Chinese, ex-whse.	31	0	0
Crude	20	0	0

QUICKSILVER

Quicksilver 10 10 0 to 10 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	13 0 0
75%	18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/9 lb.
Tungsten metal powder—	
98/99%	3/- lb.
Ferro-chrome—	
2/4% car.	32 0 0
4/6% car.	23 0 0
6/8% car.	21 12 6
8/10% car.	21 12 6
Ferro-chrome—	
Max. 2% car.	37 10 0
Max. 1% car.	38 15 0
Max. 0.70% car.	42 0 0
70%, carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 7/64 in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

South Wales—	£	s.	d.	£	s.	d.
Heavy steel	2	12	6 to	2	15	0
Bundled steel and shrngs.	2	7	6 to	2	15	0
Mixed iron and steel	2	8	0 to	2	10	0
Heavy cast iron	2	5	0 to	2	7	6
Good machinery	2	7	6 to	2	10	0
Cleveland—						
Heavy steel				2	7	6
Steel turnings				1	17	6
Cast-iron borings				1	7	6
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	10	0 to	2	13	0
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron				3	0	0
Steel turnings, f.o.r.				1	13	0
Scotland—						
Heavy steel	2	12	6 to	2	15	0
Ordinary cast iron	2	14	0 to	2	15	0
Engineers' turnings				2	2	6
Cast-iron borings	2	0	0 to	2	1	3
Wrought-iron piling				2	13	9
Heavy machinery				2	18	6

London—Merchants' buying prices, delivered yard.

Copper (clean)	28	0	0
Brass	20	0	0
Lead (less usual draft)	10	10	0
Tea lead	8	0	0
Zinc	9	10	0
New aluminium cuttings	70	0	0
Braziery copper	25	0	0
Gunmetal	26	0	0
Hollow pewter	155	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	57/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	68/-
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/-
Clyde, No. 3	83/-
Monkland, No. 3	83/-
Summerlee, No. 3	83/-
Eglinton, No. 3	83/-
Gartsherrie, No. 3	83/-
Shotts, No. 3	83/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	12	6 to	9	15	0
Nut and bolt iron	7	5	0 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ⅜ in. × 4 in.	13	15	0			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	5	0 to	9	10	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)				8	12	0
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates	12	5	0 to	12	10	0
Hoops (Staffs)	10	10	0 & up.			
Black sheets, 24g. (4-t. lots)				10	5	0
Galv. cor. shts. (,,)				12	15	0
Galv. flat shts. (,,)				13	5	0
Galv. fencing wire, 8g. plain				14	10	0
Billets, soft				5	10	0
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	5	0
Tin bars				5	0	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	11¾d.
Rods	11d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic, Valley	17.00
Bessemer	19.76
Malleable, Valley	17.50
Grey forge, Valley	17.50
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	26.00
Sheet bars	26.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	1.89
Steel bars	1.75
Tank plates	1.79
Beams, etc.	1.70
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.35
Plain wire	2.20
Barbed wire, galv.	2.85
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	21/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		16/3 to 16/6
,,	28×20	,,	32/6 to 33/-
,,	20×10	,,	23/6 to 23/9
,,	18¾×14	,,	17/3
C.W.	20×14	,,	15/-
,,	28×20	,,	31/- to 31/3
,,	20×10	,,	21/6 to 21/9
,,	18¾×14	,,	15/- to 15/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Mar.	28 ..	32 0 0	dec. 10/–
,,	29 ..	32 5 0	inc. 5/–
April	3 ..	32 7 6	,, 2/6
,,	4 ..	32 3 9	dec. 3/9

Standard Tin (cash)

		£ s. d.	
Mar.	28 ..	237 10 0	dec. 27/6
,,	29 ..	238 12 6	inc. 22/6
April	3 ..	237 5 0	dec. 27/6
,,	4 ..	235 5 0	,, 40/–

Spelter (ordinary)

		£ s. d.	
Mar.	28 ..	14 17 6	No change
,,	29 ..	15 2 6	inc. 5/–
April	3 ..	14 17 6	dec. 5/–
,,	4 ..	14 13 9	,, 3/9

Zinc Sheets (English)

		£ s. d.	
Mar.	28 ..	24 10 0	No change
,,	29 ..	24 10 0	,, ,,
April	3 ..	24 10 0	,, ,,
,,	4 ..	24 10 0	,, ,,

Electrolytic Copper

		£ s. d.	
Mar.	28 ..	35 5 0	dec. 5/–
,,	29 ..	35 10 0	inc. 5/–
April	3 ..	35 10 0	No change
,,	4 ..	35 10 0	,, ,,

Tin (English ingots)

		£ s. d.	
Mar.	28 ..	238 0 0	dec. 30/–
,,	29 ..	239 15 0	inc. 35/–
April	3 ..	238 0 0	dec. 35/–
,,	4 ..	236 0 0	,, 40/–

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
Mar.	28 ..	17 2 6	dec. 2/6
,,	29 ..	17 7 6	inc. 5/–
April	3 ..	17 5 0	dec. 2/6
,,	4 ..	17 5 0	No change

Lead (English)

		£ s. d.	
Mar.	28 ..	13 0 0	No change
,,	29 ..	13 0 0	,, ,,
April	3 ..	13 0 0	,, ,,
,,	4 ..	12 15 0	dec. 5/–

AVERAGE MONTHLY PRICES OF STEEL RAILS

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	24 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 8	8 7 8
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	—	—	—	—	—	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10
1933	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 3	60 7½	62 6	62 6	59 8½
1934*	62 6	65 0	67 6	—	—	—	—	—	—	—	—	—	—

* Since March, 1934, delivered works: previously f.o.t. furnaces.

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